California State Teachers' Retirement System

2020 Experience Analysis

January 2020 Meeting

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Teachers' Retirement Board
California State Teachers' Retirement System

Re: **California State Teachers' Retirement System 2020 Experience Analysis**

Dear Members of the Board:

It is a pleasure to submit this report of experience analysis of the California State Teachers' Retirement System (CalSTRS) for the period July 1, 2015 through June 30, 2018. The results of this analysis are the basis for the actuarial assumptions and methods to be used in the actuarial valuations to be performed as of June 30, 2019.

Actuarial Certification

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, 2018 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 that anticipated by the economic or demographic assumptions; changes in economic or demographic assumptions; increases or decreases expected as part of the natural operation of the methodology used for these measurements (such as the end of an amortization period or additional cost or contribution requirements based on the plan's Funded Ratio); and changes in plan provisions or applicable law.

Due to the limited scope of our assignment, we did not perform an analysis of the potential range of 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.

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This experience analysis 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.

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

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

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

We would like to acknowledge the help in the preparation of the data for this analysis given by the CalSTRS staff.

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We respectfully submit the following report and we look forward to discussing it with you.

Sincerely,

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Consulting Actuary

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Consulting Actuary

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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 and adjusting the contributions as necessary to maintain adequate funding.

To ensure the ongoing reasonableness of the assumptions used in the valuation, they should be studied regularly. This process is called an experience analysis (or experience study). As the board is scheduled to adopt the assumptions at its January 2020 meeting, we will refer to this report as the 2020 Experience Analysis.

Recommendations and Considerations

We have divided our proposed assumption and method changes into two categories:

- **Recommendations:** These are assumptions and methods that we recommend the board adopt for use in the June 30, 2019 actuarial valuations.
- **Alternatives for Consideration:** These are assumptions where there is justification to support a change, but it is not sufficiently compelling to make a full recommendation or there are other factors that support not making the change. We believe these assumptions are also reasonable and have provided them for the board's consideration. Note that in combination this package of assumptions would be more conservative than the base recommended package. For example, the alternative assumptions include a lower investment return assumption (6.50% or 6.75%), so there would be a greater probability of achieving the alternative return assumption than the current 7.00%. Like all assumptions, they should continue to be monitored going forward, whether or not one of the alternatives is adopted.

Summary of Results

This section describes the key findings of this experience analysis of CalSTRS for the period July 1, 2015 through June 30, 2018. Note that because 2019 valuation data was not available when the experience study commenced, we have performed a three-year study ending in 2018. This is consistent with the approach that has been used in prior studies. Note that although this analysis only covers the three-year period, we also considered the results of prior studies in making our recommendations.

We are recommending several changes to the demographic and economic assumptions, as well as certain actuarial methods. Note that the recommended changes to the economic assumptions only apply to the Defined Benefit Supplement (DBS) and Cash Balance Benefit (CBB) Programs. Throughout this report, we will refer to the outcomes based on our recommended assumptions as the "proposed" assumptions and the outcomes based on the current assumptions as the "expected" assumptions. In addition, we have noted some changes to the economic assumptions for the board to consider, but these are not included in our base recommended package of assumptions.

The following are the two changes that we are recommending that would have the greatest impact on the Funded Ratio or the employer and state contribution rates.

- **Termination Assumption:** The termination assumption encompasses members leaving active employment for reasons other than death, disability or service retirement. We are recommending reduced termination rates to better reflect recent experience. This recommendation also takes into account that

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members working full-time for their entire career have lower termination rates than those working part-time or those who previously had a break in their service.

- **Service Retirement Assumption:** We are recommending changes in the service retirement assumptions to reflect recent experience. We are also recommending additional modifications to the age-based rates to better reflect the correlation between the probability of retirement and the member's credited service.

All of the other base recommendations are expected to have lesser impacts on the projected contributions needed and the Funded Ratio of the system.

If adopted, the recommended assumptions would result in essentially no change in the estimated Funded Ratio as of June 30, 2019 and an increase in future state and employer contribution rates (primarily for the state), as compared to the current assumptions. Note that there is not expected to be any impact on the state and employer contribution rates calculated in the June 30, 2019 DB Program valuation, as the state increase is already projected to increase at the maximum rate (0.5% increase) and the employer contribution rate for the fiscal year beginning July 1, 2020 is fixed in statute. If the additional economic assumption changes we have included for board consideration were adopted, this could have a greater financial impact. It is expected there would be no impact on member contribution rates if the recommended assumptions are adopted; however, if a reduction in the investment return assumption were adopted, as included with the considerations, this could trigger an increase in the 2% at 62 member rates. This is discussed further in the Financial Impact section at the end of the Executive Summary.

Summary of Recommended Changes (Economic)

The following table shows a summary of our base recommendations for the economic assumptions, as well as some alternatives for board consideration. Note that where the recommendations or alternatives for consideration differ from the current assumption, the values are shown in bold.

	DB Program			CBB / DBS Programs		
	Current	Base Recommendation	Alternative	Current	Base Recommendation	Alternative
Consumer Price Inflation[1]	2.75 %	2.75 %	2.75 %	2.75 %	2.75 %	2.75 %
Net Real Rate of Return	4.25	4.25	**4.00**	3.75/4.25	3.75/4.25	**3.50/4.00**
Investment Return [2][3]	7.00 %	7.00 %	**6.75** %	6.50/7.00 %	6.50/7.00 %	**6.25/6.75** %
Interest on Member Accounts	3.00 %	3.00 %	3.00 %	6.50/7.00 %	6.50/7.00 %	6.25/6.75 %
Consumer Price Inflation	2.75 %	2.75 %	2.75 %	n/a	n/a	n/a
Real Wage Inflation	0.75	0.75	**0.50**	n/a	n/a	n/a
Wage Growth	3.50 %	3.50 %	**3.25** %	n/a	n/a	n/a
Payroll Growth	3.50 %	3.50 %	**3.00** %	n/a	n/a	n/a
Portfolio Standard Deviation	N/A %	N/A %	N/A %	15.00/13.00 %	**13.10/11.00** %	**13.10/11.00** %

1. 2.50% would also be a reasonable price inflation assumption.
2. Net of investment and administrative expenses.
3. 7.00% is not the only reasonable investment return assumption. Alternative investment return assumptions of 6.50% or 6.75% (6.00% or 6.25% for CBB Program) would also be reasonable in our opinion.

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Summary of Recommended 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	No change
Beneficiaries	No change
Disabled Members	No change
Active Members	Reduce rates
Service Retirement	
Retirement from Active Membership	Adjust rates & add additional service levels
Retirement from Vested Membership	No change
Disability	
Coverage A	Reduce rates
Coverage B	Reduce rates
Other Terminations of Membership	
Termination	Reduce rates
Probability of Refund	Make small changes at some age/svc levels
Salary Increases for Merit	No change
Miscellaneous Assumptions	
Load for Sick Leave Service	Reduce
Probability of Marriage	No change
Number of Children	No change
Offsets for Death & Disability	No change
Valuation of Current Inactive Members	No change
Split between 1990 and New Benefits for Current Retirees	Update estimates based on retirement year

All assumptions recommended for the DB Program are also recommended to be used for the June 30, 2019 actuarial projection of the Supplemental Benefit Maintenance Account (SBMA) and the June 30, 2019 valuation of the Medicare Premium Payment (MPP) Program.

Summary of Recommended Changes (MPP Program)

The following table shows a summary of our recommendations for the assumptions specific to the MPP Program.

MPP-Specific Assumption	Recommended Changes
Enrollment	Decreases at most ages
Part A Premium Increases	Increased trend rates
Part B Premium Increases	Increased trend rates

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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 not recommended any changes to the current DB Program economic assumptions, although we have suggested several changes to be considered.

As discussed in Section 2, price inflation historically has averaged higher than the current 2.75% assumption; whereas, experience over the last 20 years and forecasts for future inflation are lower. It should be noted that there has been a recent rise in price inflation in California; however, national forecasts have remained low and interest rates have continued to decline. Although we consider the current 2.75% assumption to be reasonable and have included it in our base recommendations, consideration should also be given to a lower inflation assumption, such as 2.50%.

Over the last 50 years, wages for all occupations have exceeded price inflation by 0.5%, although the difference has been higher (0.8%) over the last 30 years. Our recommendation is that the difference between wage growth and inflation remain at 0.75%, resulting in a total general wage growth assumption of 3.50%, as well as a 3.50% assumption used to project future payroll. We note that historically the wage growth for California teachers has been close to price inflation, indicating lower wage growth than the assumption. Additionally, our analysis shows some constraints on payroll growth. We have therefore included slightly lower wage growth and payroll growth assumptions for the board's consideration.

Based on the CalSTRS current capital market assumptions and target asset allocation, the current 7.00% investment return assumption for the DB Program is equal to the expected median long-term return (net of expenses). Our recommendation is to retain the current assumption. However, as discussed in more detail in Section 2, recent changes in the economic environment, particularly declining interest rates, are putting downward pressure on expected returns. We have therefore included lower investment return assumptions for consideration. For the DBS Program, we recommend the return assumption continue to be set equal to the DB Program as the DBS Program assets are invested similarly to the DB Program. For the CBB Program, we continue to recommend the assumption be set 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 alternatives discussed are reasonable is based on the advice of outside experts as provided for in the Actuarial Standards of Practice, in this case the capital market assumptions adopted by CalSTRS, based on advice from their investment staff and consultants. Based on Milliman's January 2019 capital market assumptions, we project a 20-year expected return about 0.5% less than using the CalSTRS capital market assumption. However, it should be noted that Milliman's capital market assumptions are based on an inflation assumption that is about 0.5% less than used by CalSTRS. Therefore, the assumed real rate of return (investment return less price inflation) between the two sets of capital market assumption is consistent. Note that since January 2019, there has been a significant decline in interest rates, which will likely put downward pressure on future expected returns.

We are recommending no change to the interest assumed to be credited to members' accounts in the DB Program (3.00%) which is 0.25% over price inflation. This reflects a middle ground between the historical return on two-year treasuries (which the interest rate is based on) which has averaged less than price inflation over the last 15 years, and our internal forecasts which project returns slightly greater than price inflation.

For the DBS and CBB 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 under the board policy is to allocate all investment earnings to the member accounts over the long term.

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Under board policy, the calculation of the additional earnings credits for the DBS and CBB 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 13.1% for the DBS Program (previously 15.0%) and 11.0% for the CBB Program (previously 13.0%). 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:

- **Asset Valuation Method** (for funding) – We are recommending the current method of smoothing actuarial asset gains and losses be retained. We are recommending a technical modification to the treatment of the accounting value assigned to expected future benefits provided to CalSTRS staff.
- **Actuarial Cost Method** (for funding) – We are recommending the current cost method (the Entry Age Normal Cost Method) be retained with a technical modification to remove adjustments to the Normal Costs determined for the individual plan coverages.
- **Sick Leave** – We are recommending a small reduction in the additional sick leave that members are assumed to have at service retirement.
- **Option Factors** – We are recommending some small updates to the assumptions used for the option factors.
- **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 for future retirements. For current retirees, historical averages are used. We are recommending updates to the historical measurements to reflect the last three years' experience.

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 changes to the demographic assumptions that we are recommending are changes to the termination and service retirement assumptions.

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 (black bar), the current assumption (green line), and the new proposed assumption (orange line).

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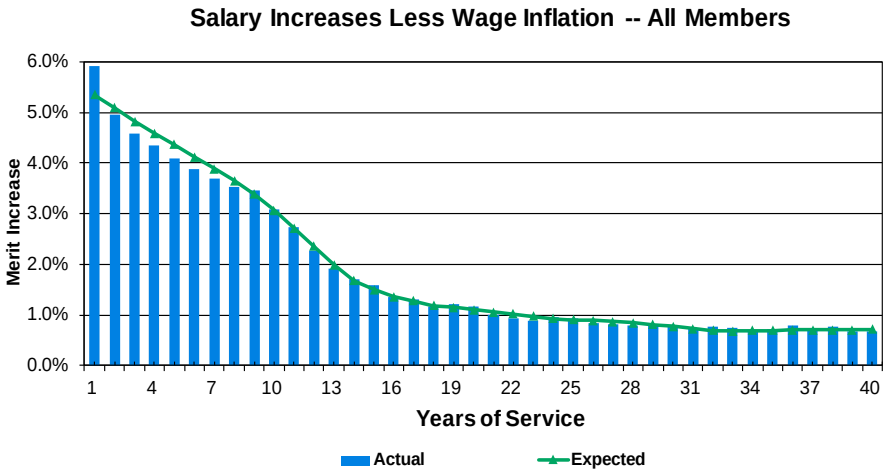
The recommended rates are shown in detail in Appendix A.

Individual Salary Increases due to Promotion and Longevity (Merit)

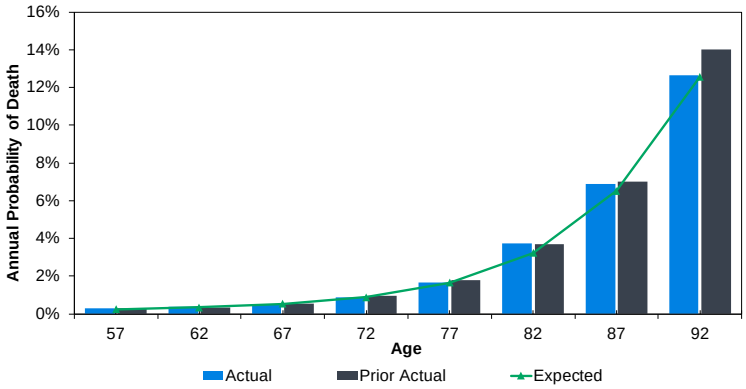
Section 4 discusses the individual salary increases due to promotion and longevity – the merit component of salaries. Our analysis of the merit salary combines the prior four studies due to the variation we typically see in this assumption from one study to the next. Overall, the results show increases have been close to the current rates predicted (as shown in the following graph), and we are not recommending any changes to this assumption. See Section 4 for more details on this analysis.



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. The current assumptions include a projection scale that reflects the gradual year-to-year improvement in mortality that is expected to occur in the future.

The actual mortality experience over the three-year study period was close to that projected by the assumptions (see following graph of female retirees). We are not recommending any changes in the mortality assumptions. Additional details are provided in Section 5.



Death from Active Status

Overall, the actual number (1,122) of deaths from active status where an annuity was elected was lower than what the assumptions predicted (1,224). We are recommending reduced mortality rates for active members. Further analysis is shown in Section 6 of this report.

Service Retirement

Overall, the number of service retirements from active status was close to what the assumptions predicted, although there were some differences at the various service levels. In particular, members with more than 30 years of service retired at a slightly lower rate than assumed during the period, as shown in the table below.

Number of Service Retirements (2% at 60) — Expected			
	Actual	Expected	Actual / Expected
Less than 25 Years of Service	15,362	14,153	109%
25 to 30 Years of Service	6,920	6,344	109%
30 Years or More of Service	11,010	12,064	91%
Total	33,292	32,561	102%

We are recommending some modifications in the service retirement rates for 2% at 60 members to reflect actual experience. In particular, we have proposed an overall increase in the assumed rates for members with less than 30 years of service and a slight reduction in the rates at 30 or more years of service. We have also recommended some additional adjustments within the service groups.

The table below illustrates the actual number of service retirements for the 2% at 60 group, 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	15,362	14,754	104%
25 to 30 Years of Service	6,920	6,826	101%
30 Years or More of Service	11,010	11,474	96%
Total	33,292	33,054	101%

For the 2% at 62 members (for whom there is insufficient retirement experience to allow for statistically meaningful analysis), we are recommending some refinements to the current rates, which are currently based on age, to also reflect the impact of a member's service level on his or her probability of retiring in a year.

We are recommending similar changes to the 1990 Structure Benefits that adjust the retirement rates based on credited service, which is in addition to the current approach which varies rates by age. Note that as the 1990 Structure has not applied for nearly 20 years, we do not have any recent experience to assess what the actual retirement rates would be under 1990 Benefit Structure. Historically, the approach has been to maintain the retirement rates from the time the prior structure last applied, which used rates based on age only. We are recommending the change to incorporate credited service to better reflect current actuarial practice and to be consistent with the approach currently used for the current benefit structure for 2% at 60 members.

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Both of these modifications are designed to result in approximately the same expected number of retirements as the current rates project, but have higher rates at higher levels of service (and lower rates at lower levels of service) for a given age.

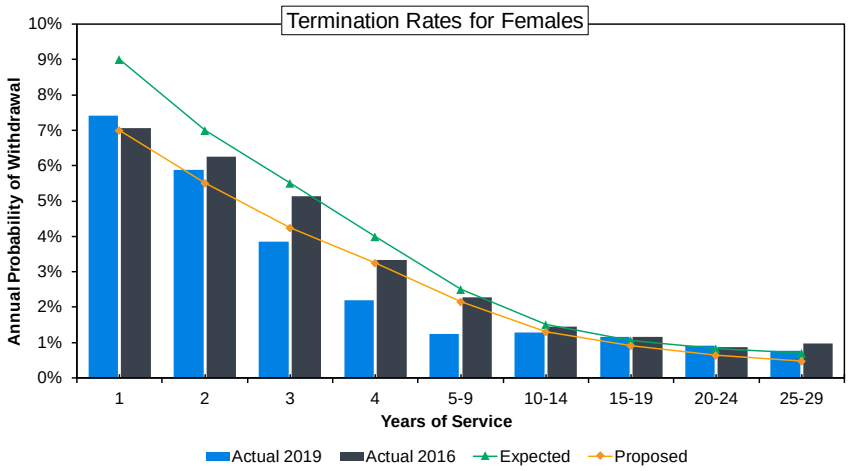
Further analysis is shown in Section 7 of this report.

Disability Retirement

Overall, the actual number (1,209) of disability retirements was lower than what the assumptions predicted (1,624). We are recommending reduced rates of disability retirement for both Coverage A and B. Further analysis is shown in Section 8 of this report.

Other Terminations of Employment

The termination assumption encompasses members leaving active employment for reasons other than death, disability or service retirement. The current study shows actual rates of termination that are lower than the current assumptions (expected rates) and lower than observed in the prior study (see following graph). We have recommended decreased rates. In making this recommendation, we also considered that members working full-time for their entire career have lower termination rates than those who have worked part-time or previously had a break in their service. Since a full-time member has greater credited service than a part-time member at the same level of elapsed service, full-time members will have a relatively greater impact on the actuarial obligation. Therefore, we gave greater weight to the full-time service group who have lower rates of termination to better reflect their impact on the actuarial obligation. Further analysis is shown in Section 9 of this report.



Probability of Refund upon Vested Termination

The actual number of refunds (2,873) paid to vested members at termination was less than the assumptions predicted (3,098). We are recommending small decreases in this assumption and removing the distinction between male and female. Further analysis is shown in Section 10 of this report.

Financial Impact – Recommended Assumptions (DB Program)

The following exhibit shows the expected financial impact on the funding of the DB Program if the recommended package of assumptions is adopted. If these changes are adopted, the total state and employer contribution rates are projected to increase (relative to if the changes were not made), and the Funded Ratio of the DB Program is

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not expected to be impacted by the changes. Note that for purposes of these estimates, we have not reflected the impact of the one-time, supplemental contribution made by the state on behalf of the employers resulting from SB 90.

The financial impact was evaluated by performing additional valuations with the June 30, 2018 valuation data and reflecting the proposed assumption changes. We then projected the results to June 30, 2019 with a 6.8% investment return for the fiscal year ended June 30, 2019. The actual financial impact will vary somewhat for the June 30, 2019 valuation due to year-to-year changes.

Based on the 2018 valuation, the state contribution rate was projected to increase to a little over 9.0% of pay in fiscal year 2022-23 and then level off at about 9.0% of pay after that. The gradual increase prior to 2022-23, instead of an immediate increase, is due to constraints on the annual increase in the state contribution rate. The employer contribution rate is on a fixed increasing schedule as a percentage of pay until fiscal year 2021-22 when it is calculated on an actuarial basis within certain constraints. To estimate the impact of the proposed changes on the state and employer contribution rates, we have shown the projected rates for fiscal year 2023-24 in our analysis, as the constraints on contribution rate increases are not projected to apply in this year and the employer contribution rates will be variable by then.

	Normal Cost %		Funded	Projected Contribution Rate in FY2023-24	
	2% at 60	2% at 62	Ratio	State	Employer
June 30, 2018 Actuarial Valuation	**20.56%**	**17.86%**	**64.0%**	**9.09%**	**18.16%**
Projected Impact with 6.8% FYE2019 Return	0.00%	0.00%	1.0%	0.08%	-0.01%
June 30, 2019 Actuarial Valuation (Est.)	**20.56%**	**17.86%**	**65.0%**	**9.17%**	**18.15%**
Recommended Changes					
Termination Rate Changes	0.35%	0.26%	0.0%	0.28%	0.10%
Service Retirement Rate Changes	0.07%	0.06%	-0.1%	0.13%	-0.13%
Actuarial Method Changes	-0.07%	0.00%	0.1%	0.00%	0.08%
All Other Changes[1]	0.01%	-0.02%	0.0%	0.05%	-0.02%
Subtotal for Recommended Changes	0.35%	0.30%	0.0%	0.46%	0.03%
June 30, 2019 Actuarial Valuation (Est.) with Recommended Changes	**20.91%**	**18.16%**	**65.0%**	**9.63%**	**18.18%**

1. Assumptions for active death rates, probability of refund, and sick leave credit at retirement.

Note that if the base recommended assumptions are adopted, it is expected to result in a relatively minor increase in the Unfunded Actuarial Obligation (UAO) and a small shift in the allocation between the state and the employers. For example, if the assumption changes were reflected in the June 30, 2018 DB Program valuation, the total UAO would have been $107.5 billion (a $0.3 billion increase). This amount is made up of the 1990 Structure UAO of $34.0 billion (a $0.6 billion increase), which the state is responsible for funding, and the UAO for post-2014 "new" benefits of $73.2 billion (a $0.3 billion decrease), which the employers are responsible for funding. The remaining piece, the Unallocated UAO, is $0.3 billion (no change).

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Financial Impact – Alternative Assumption Changes for Consideration

Note that the recommended assumptions are not the only set of assumptions that we would consider reasonable. As discussed in Section 2, it would be reasonable for the board to select alternative economic assumptions. We have provided the estimated financial impact of these alternative assumption changes. Note that in combination this package of alternative assumptions would be more conservative than the base recommended package.

To estimate the impact of the proposed changes on the state and employer contribution rates, we have shown the rates for fiscal year 2028-29 in our analysis, as the constraints on state contribution rate increases are projected to apply until this year under the 6.75% investment return assumption scenario.

	Normal Cost %		Funded	Projected Contribution Rate in FY2028-29	
	2% at 60	2% at 62	Ratio	State	Employer
June 30, 2019 Actuarial Valuation (Est.) with Recommended Changes[1]	**20.91%**	**18.16%**	**65.0%**	**9.38%**	**18.22%**
Additional Considerations					
Wage Inflation and Payroll Growth (3.25%)	-0.81%	-0.31%	0.5%	-1.04%	0.49%
Payroll Growth (3.00%)	0.00%	0.00%	0.0%	0.14%	0.49%
Investment Return (6.75%)[2]	1.39%	1.18%	-2.0%	3.63%	-0.59%
Subtotal for Additional Considerations	0.58%	0.87%	-1.5%	2.73%	0.39%
June 30, 2019 Actuarial Valuation (Est.) with Additional Changes	**21.49%**	**19.03%**	**63.5%**	**12.11%**	**18.61%**

1. Differences in projected contribution rates from previous table due to different fiscal year shown.
2. 6.50% would also be a reasonable assumption.

Financial Impact – Member Contribution Rates

Contribution rates for 2% at 60 members are fixed 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. As the Normal Cost rate will change year to year due to assumption changes and changes in demographics of the group, 2% at 62 member contribution rates can vary from year to year. 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 18.16% of pay. This compares to the rate at the last adjustment of 17.89% of pay. As the change is not close to 1% of pay, it is highly unlikely that when the 2019 valuation is completed, the change in the Normal Cost rate for 2% at 62 members would exceed 1.00% and require an increase or decrease to their contribution rate if only the recommended package of assumptions is adopted.

If the recommended assumptions were adopted and the investment return assumption was lowered below 7.00% (as shown with the alternative assumption changes), it would be likely that there would be an increase in the contribution rate for 2% at 62 members.

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Financial Impact – Unallocated Unfunded Actuarial Obligation

The funding legislation included actuarial funding (within certain constraints) for most of the benefits provided by CalSTRS. The one exception is that there is no provision for the state, employers, or members to fund any UAO arising for New Benefits (i.e., those not included in the 1990 Benefit Structure) attributable to service after June 30, 2014, referred to as the "Unallocated UAO". Under the valuation policy, a portion of each year's total contributions, equal to the Normal Cost of the New Benefits, is allocated to fund these benefits. Since the allocated contribution is equal to that Normal Cost, there are no remaining contributions to pay down the Unallocated UAO. Therefore, the Unallocated UAO will increase or decrease based on future experience and changes in actuarial assumptions.

As previously discussed, we are proposing a change to the 1990 Benefit Structure retirement rates to vary them by both age and service level. By changing the 1990 Benefit Structure retirement rates to be consistent with the method used for retirement rates under the current structure, this shifts a portion of the actuarial obligation to the 1990 Benefit Structure; however, there is no corresponding increase in the actuarial obligation for the current structure. This change in method by itself would create a discontinuity with the prior valuation that would materially affect the Unallocated UAO. Therefore, we have included an offsetting adjustment to the 1990 Structure UAO, so the Unallocated UAO is not affected by the change in the method used for the 1990 Benefit Structure retirement rates.

We are projecting that the Unallocated UAO will see a small increase in the next valuation due to the other proposed changes included in the recommended package of assumptions.

Financial Impact – Projected 2046 Funding

The 2018 valuation showed the DB Program was projected to be approximately fully funded by 2046. Applying the recommended package of assumptions to the 2018 valuation, the contributions to the DB Program are projected to be sufficient to reach full funding by 2046; however, higher state and employer contribution rates (relative to those projected in the 2018 valuation report) would be required, with the increase primarily falling on the state.

If all of the alternative economic assumptions were adopted, the DB Program would also be projected to be approximately 100% funded in 2046, and the state and employer contribution rates would be expected to be greater.

The projection assumptions are the same as those stated on page 7 of our 2018 DB Program valuation report, except for the reflection of the assumptions recommended in this report and the inclusion of the estimated FYE2019 investment return of 6.8%.

Financial Impact – DBS and CBB Programs

There would be no impact on the DBS or CBB Actuarial Obligations if the recommended assumptions are adopted, as the non-retired group is valued based on the account values and not affected by the assumptions. The Actuarial Obligation for retirees is only affected by changes in mortality and the investment return assumption, so there would be no impact on retirees either.

If the investment return assumption were lowered to 6.50% or 6.75%, as included with the alternatives for board consideration, the impact on the Funded Ratio of these programs would be less than 1%.

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Financial Impact – SBMA

The funding of the SBMA is currently projected to be sufficient at the 85% purchasing power level. This would not be affected by either the recommended package of assumptions or the alternatives.

Financial Impact – MPP Program

The proposed increases in the Medicare trend rates are projected to increase the actuarial obligation of the MPP Program, but this is not expected to change the conclusion of the 2018 valuation that there is adequate funding.

Variance of Future Results

The previous analysis showed the estimated financial impact under various assumption and method changes. It is virtually certain that future experience will not exactly match the assumptions. 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. This potential variance is discussed in more detail in our actuarial valuation reports and the "2019 Review of Funding Level and Risks" completed by CalSTRS internal actuarial staff.

Complete List of Revised Assumptions and Methods

Appendix A illustrates the Summary of Actuarial Assumptions as it will appear in the June 30, 2019 valuation report, if all recommended assumptions and methods are adopted. Proposed changes in assumptions are highlighted in yellow. The Appendix does not show any of the alternative assumptions we have provided for board consideration. The recommended assumptions are for use with CalSTRS funding calculations.

Assumptions and Methods to be used for Financial Reporting

In general, the assumptions and methods adopted for the June 30, 2019 funding valuations should also be used for June 30, 2020 financial reporting under Governmental Accounting Standards Board (GASB) Statements 67, 68, 74 and 75. The following are exceptions. None of these represent a change from the current methods.

- Asset method: The Fiduciary Net Positon reported in CalSTRS financial statements should be used.
- Actuarial cost method: The Entry Age Normal Cost Method should be used for all programs. Note that currently an adjustment is made to the funding valuation to explicitly value Coverage A benefits for Normal Cost purposes in the GASB valuation. If the proposed change in the actuarial cost method for funding is adopted, this adjustment would no longer be needed.
- Discount rate (GASB 67/68): The discount rate used in the GASB 67/68 valuations is equal to the investment return assumption used for funding purposes plus an adjustment of 0.10% to make the value gross of administrative expenses. Thus, if the recommended package of assumptions is adopted, the discount rate should remain at 7.10%.
- Discount rate (GASB 74/75): The discount rate used in the GASB 74/75 is set equal to the municipal bond index and updated annually.

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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 combination 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.

ASOP No. 27 states that for the assumption to be considered reasonable, it should, among other things, reflect "the actuary's estimate of future experience" and have "no significant bias (i.e., it is not significantly optimistic or pessimistic)."

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 base recommendations and other alternative assumptions that would also be reasonable and the board may wish to consider (changes from current assumptions are shown in bold). Note that in combination the package of alternative assumptions would be more conservative than the base recommended package.

	DB Program			CBB / DBS Programs		
	Current	Base Recommendation	Alternative	Current	Base Recommendation	Alternative
Consumer Price Inflation[1]	2.75 %	2.75 %	2.75 %	2.75 %	2.75 %	2.75 %
Net Real Rate of Return	4.25	4.25	**4.00**	3.75/4.25	3.75/4.25	**3.50/4.00**
Investment Return [2][3]	7.00 %	7.00 %	**6.75** %	6.50/7.00 %	6.50/7.00 %	**6.25/6.75** %
Interest on Member Accounts	3.00 %	3.00 %	3.00 %	6.50/7.00 %	6.50/7.00 %	6.25/6.75 %
Consumer Price Inflation	2.75 %	2.75 %	2.75 %	n/a	n/a	n/a
Real Wage Inflation	0.75	0.75	**0.50**	n/a	n/a	n/a
Wage Growth	3.50 %	3.50 %	**3.25** %	n/a	n/a	n/a
Payroll Growth	3.50 %	3.50 %	**3.00** %	n/a	n/a	n/a
Portfolio Standard Deviation	N/A %	N/A %	N/A %	15.00/13.00 %	**13.10/11.00** %	**13.10/11.00** %

1. 2.50% would also be a reasonable price inflation assumption.
2. Net of investment and administrative expenses.
3. 7.00% is not the only reasonable investment return assumption. Alternative investment return assumptions of 6.50% or 6.75% (6.00% or 6.25% for CBB Program) would also be reasonable in our opinion.

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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 project 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 2.75% per year. Our recommendation is to retain this assumption.

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 table below shows the compounded annual inflation rate for various 10-year periods, and for the 50-year period ended in December 2018. Note that the 50-year average is heavily influenced by the inflation of the late 1970s and early 1980s. The last 30 years have averaged closer to 2.5%.

Decade	CPI Increase
2009-2018	1.8%
1999-2008	2.5%
1989-1998	3.1%
1979-1988	5.9%
1969-1978	6.7%
Prior 50 Years	
1969-2018	4.0%

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 1969-2018, compared to the national average of 4.0%.

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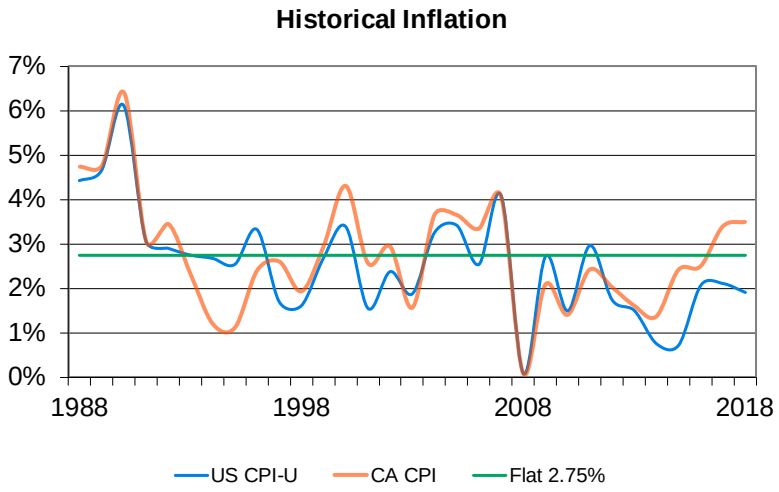
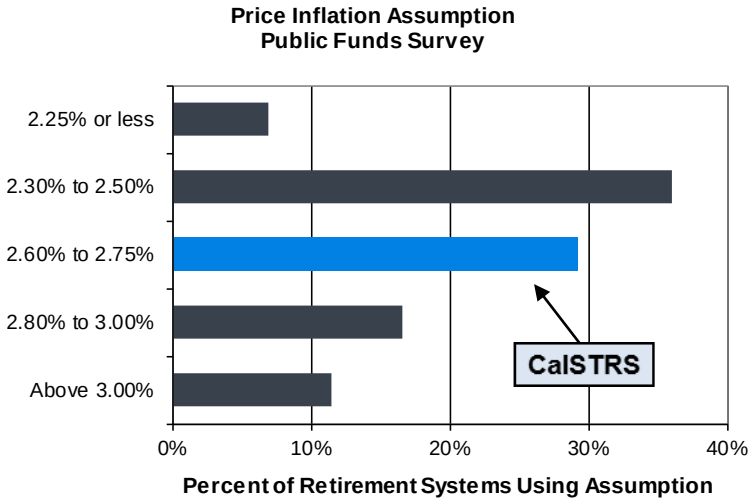
The following graph shows historical national CPI increases over the last 30 years. The actual CPI increase has generally been less than 2.75% during the last 25 years of the period. Also shown for comparison are CPI increases specific to California. These have tracked fairly closely to the national statistics, although over each of the last four years, California CPI has exceeded the national CPI by 1.0% on average.



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 median assumption is 2.75%, so CalSTRS is in the mainstream, although the assumption has been trending down and the most common assumption is now 2.50%. The following graph shows this distribution.



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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 2019 suggest investors expect inflation to be about 1.8% over the next 30 years. Most forecasts of future price inflation by economists and investment professionals are lower than 2.75%, although they are generally 2.0% or greater.

We reviewed the expected increase in future CPI used by the Office of the Chief Actuary for the Social Security Administration. In the 2019 Trustees Report, the projected average annual increase in the CPI over the next 75 years under the intermediate cost assumptions was 2.60%.

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.

Inflation over the last 10 years has averaged nearly 1% less than the 2.75% assumption; however, there has been a recent uptick, particularly in California, with the weighted average CPI for California averaging over 3.0% annually for the last three years. The CalSTRS inflation assumption is close to that projected by Social Security actuaries and is the median assumption amount of other large retirement systems. Our recommended package of assumptions includes no change in the long-term assumed inflation rate of 2.75%, although we have also included a lower assumption of 2.50% for the board's consideration.

Price Inflation	
Current Assumption	2.75%
Base Recommendation	2.75%
Alternative for Consideration	2.50%

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2. Wage and Payroll 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 for California, 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 1969 to 2018.

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 2018. 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
2009-2018	2.2%	1.8%	0.4%
1999-2008	3.7%	2.5%	1.2%
1989-1998	4.1%	3.1%	1.0%
1979-1988	6.2%	5.9%	0.3%
1969-1978	6.6%	6.7%	-0.1%
Prior 50 Years			
1969-2018	4.5%	4.0%	0.5%

These are national statistics for all jobs. For comparison, the average increase in the real wage (compared to California-specific inflation) for members of CalSTRS has been 0.0% for the most recent 30-year period. This is significantly less than the national average which increased 0.8% more than US inflation over the last 30 years and 0.5% for the last 50 years.

Forecasts of Future Wages

Wage inflation has been projected by the Office of the Chief Actuary of the Social Security Administration. In the 2019 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 2.6% per year.

Reasonable Range and Recommendation

Over the last 50 years, the actual experience, on a national basis, has been less than the current 0.75% real wage increase assumption. When looking over a more recent period (30 years), actual experience has been close to the current assumption. Our analysis shows that actual real wage increases for California teachers have significantly lagged the assumption. It is unclear whether this trend will reverse itself; however, it is our understanding from discussions with CalSTRS that some recent large contracts have contained wage increases

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above CPI. Also, it is our understanding that the state has been increasing school funding which may make more money available for wages. Our base recommendation is to maintain the current assumption 0.75%, but we would also consider an alternative of 0.50% reasonable.

Real Wage Growth Rate	
Current Assumption	0.75%
Base Recommendation	0.75%
Alternative for Consideration	0.50%

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 remains at 2.75%, this would result in a total wage growth assumption of 3.50%, which is no change from the current assumption.

Payroll Increase Assumption

The aggregate payroll of CalSTRS is assumed to increase, without accounting for the possibility of an increase or decrease in membership (the current assumption is that no growth in membership will occur). The current assumption is that the payroll will increase at the same rate as the general wage growth (3.50%).

Over the last 20 years, the number of active DB Program members has increased by 0.8% per year; however, over the last 10-15 years, it has been fairly level.

There are several factors that we believe will apply downward pressure on the total CalSTRS payroll in the future:

- 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. The January 2019 study projects a decline in the student population over the next 10 years, with an average annual decrease of 0.4% per year.
- As discussed in the CalSTRS 2018 Review of Funding Levels and Risks, when a charter school is created it must decide, as part of the chartering process, whether or not to provide CalSTRS benefits to its employees. In recent years, the percentage of newly created charter schools not electing CalSTRS has been increasing. Although teachers and administrators working for charter schools not covered by CalSTRS currently represents only about one percent of CalSTRS active membership, to the extent the number of charter schools increase, this could result in a decline in future active CalSTRS membership.
- CalSTRS 2% at 62 members are subject to a more restrictive definition of creditable compensation and therefore are expected to have slightly lower pay than comparable CalSTRS 2% at 60 members. Further, this limit on creditable compensation is required by law to only increase based on price inflation. As only a very small percentage of active members are currently over this limit, the current impact on payroll is negligible; however, it is projected that there will be a material increase in this percentage in the future. Based on our analysis, the limit is expected to reduce future CalSTRS payroll growth for 2% at 62 members by about 0.12% per year.

Each of these factors is projected to have a small downward impact on future payrolls; however, there are factors that could lead to an increasing active teacher population:

- Recent increases in state funding could lead to smaller classrooms and therefore an increase in the number of active teachers needed.
- Our understanding is that there are charter school legislation proposals being discussed that could result in a mandate to participate in CalSTRS. If this type of legislation were passed, this could result in a future increase in the number of active teachers.

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Our base assumption is that the payroll increase assumption continues to be equal to the wage growth assumption. As an alternative, the board could consider adopting a payroll increase assumption that is 0.25% less that the general wage growth 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 7.00% per year, net of administrative and investment-related expenses. For the CBB Program, the assumed return is 6.50%. Based on our analysis, the current assumptions remain reasonable. Our recommended assumption set has no changes to the investment return assumption, although if the board were to consider a decrease of up to 0.50%, we believe that would also be reasonable.

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 May 2019 Investment Committee meeting) and the CalSTRS target asset allocation (adopted at the November 2019 Investment Committee meeting). The CalSTRS target asset allocation is summarized in the following table:

	Target Allocation	
	DB & DBS	CBB[1]
Global Equity	42 %	58 %
Private Equity	13	0
Real Estate	15	0
Inflation Sensitive	6	8
Fixed Income	10	14
Risk Mitigation Strategies	12	17
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.

Combining these capital market assumptions, which include an underlying inflation assumption of 2.75%, with the target asset allocation policy, we calculate the median long-term (20 years) expected rate of return to be 7.15% (7.05% after adjusting for administrative and investment 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 we believe this is a reasonable estimate for the future DB Program return.

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Capital Market Assumptions

The capital market assumptions used in our analysis are from Agenda Item 7 (pages INV148-INV149) of the May 2019 Investment Committee meeting. These assumptions are based on an underlying inflation assumption of 2.75%, which is the same as is recommended in this report. The allocation used is shown below:

	Allocation	Expected Return[1]	Standard Deviation[2]
Global Equity	42 %	7.5 %	17.6 %
Private Equity	13	9.0	24.0
Real Estate	15	6.3	14.9
Inflation Sensitive	6	6.0	12.3
Fixed Income	10	4.0	6.2
Risk Mitigation Strategies	12	4.5	10.0
Cash	2	2.4	1.0
Total	100 %	7.15 %	11.5 %

1. 20-year geometric average.
2. Standard deviation does not reflect impact of guaranteed return to SBMA.

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 the CalSTRS capital market assumptions are effectively net of all investment expenses, so no adjustment in the expected return due to investment expenses is needed.

The following table shows the ratio of total administrative expenses to the fair market value of the CalSTRS assets over the last 10 fiscal years ending June 30. The administrative 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
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
2016	189,113	182	0.10
2017	209,779	216	0.10
2018	224,869	254	0.11

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

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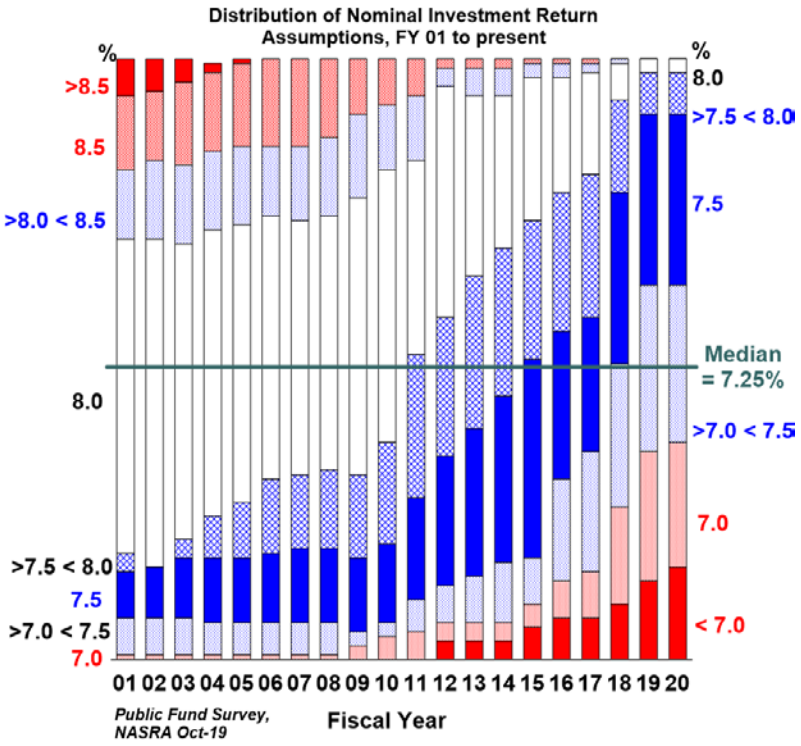
the investment return assumption is set equal to 7.00%, then CalSTRS would need to earn a return on its assets, net of investment expenses, of about 7.10% in order to net the current 7.00% assumed return for funding purposes. The assumed administrative expenses will also impact the discount rate used 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 7.25%. The following chart shows a progression of the distribution of the investment return assumptions. In 2001, very few systems had an assumption of 7.25% or lower and over 80% had an assumption of 8.0% or higher. As of fiscal year 2019, over 50% have an assumption of 7.25% or less and this is continuing to trend down.



Capital Market Assumptions Relative to Others

As noted, our analysis of the expected return has been based on the CalSTRS capital market assumptions. It should be noted that there is currently a fair amount of variation among investment professionals. For example, the expected 20-year return based on Milliman's capital market assumptions and the CalSTRS asset allocation is approximately 6.5%, net of administrative and investment expenses.

The 2019 Horizon Survey of Capital Market Assumptions provides average 10-year capital market assumptions for a number of asset classes based on a survey of 34 investment advisory firms. Combining these capital market assumptions with the CalSTRS asset allocation yields an expected return for the total portfolio of approximately 6.5%, net of administrative and investment expenses. Note that these are 10-year expected returns, as compared to the 20-year time horizon used in the CalSTRS capital market assumptions. The Horizon Survey shows average 20-year capital market assumptions for a subgroup of investment advisors that provide them. The expected return is approximately 7.25% based on the 20-year assumptions.

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It should be noted that Milliman's and Horizon'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, although not necessarily a one-to-one correspondence. This would indicate an expected return closer to the 7.0% based on the CalSTRS capital market assumptions.

Note that in our analysis of other capital market assumptions, we used the CalSTRS capital market assumptions for specific asset classes if there was not a directly corresponding asset class in the Horizon or Milliman capital market assumptions.

Timing of Capital Market Assumptions

We have primarily based our analysis on the 2019 CalSTRS capital market assumptions. Subsequent to those capital market assumptions being determined, there has been a significant decline in yields on fixed income which we believe will cause a drag on future expected returns.

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.

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 0.5% 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

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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 actuarial cost, and the employer will have to contribute less in the future. In either situation, the risk or benefit of investment underperformance or overperformance lies with the state and the employers and not the members, as the purchase cost is fixed for the member at the time of purchase.

- **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

Our recommended package of economic assumptions includes an investment return assumption of 7.00%; however, we believe it is also reasonable for the board to adopt a reduction in the assumption. In the prior section, we have shown the financial impact of using an alternative investment return assumption.

We suggest reductions of 0.25% or 0.50% in the investment return assumption also be considered. The 0.50% reduction would result in an investment return assumption of 6.50%, which is close to the 20-year expected return using Milliman's capital market assumptions and the CalSTRS target asset allocation, along with an underlying inflation assumption of 2.3%. Additionally, although the projected return over the next 20 years using the CalSTRS capital market assumptions is close to 7.0%, the general consensus is that returns over 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. Adopting a lower investment return assumption would increase the probability of the assumption being met in the future.

Conclusion

Based on portfolio analysis, the current 7.0% investment return assumption for the DB and DBS Programs is approximately equal to the expected long-term median return (net of administrative and investment expenses), based on the CalSTRS 2019 capital market assumptions. We believe the current assumption is reasonable, although we have included alternative assumptions for the board's consideration. For the CBB Program, we are recommending the assumption remain equal to the DB Program assumption less 0.5%.

Investment Return Assumption		
	DB & DBS	**CBB**
Current Assumption	7.00%	6.50%
Base Recommendation	7.00%	6.50%
Alternative Assumptions	6.75%	6.25%
	6.50%	6.00%

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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 DBS and CBB Programs, all benefits are dependent on the level of the account balance.

The current assumption is 3.00% per year for the DB Program. For the DBS and CBB 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 2000.

Excess Yield over Inflation on 2-Year Treasuries

Year	CPI	2-Year Treasury Rate	Excess / (Shortfall)
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	1.7	0.0
2005	3.0	2.6	(0.4)
2006	3.6	4.0	0.4
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	0.4	(2.5)
2013	2.0	0.3	(1.7)
2014	1.1	0.3	(0.8)
2015	0.0	0.5	0.5
2016	1.0	0.7	(0.3)
2017	2.7	0.9	(1.8)
2018	2.2	1.5	(0.7)
2019	1.5	2.6	1.1

As shown in the table, since 2010 the excess has been negative in many years as the average increase in the two-year Treasury rate has been less than inflation, by an average of 0.9%. For 10 ten years prior to that, the average excess of the two-year Treasury rate over the CPI was 1.1%, for a total excess of 0.1% over the 20-year

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period. We believe the current assumption of inflation plus a small margin to reflect the yield in excess of inflation on two-year Treasuries remains a reasonable assumption. We are recommending retaining the current assumption of 3.00% (inflation assumption plus 0.25%) for future interest crediting to DB Program accounts.

DBS and CBB Programs

For the DBS and CBB 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 investment return assumption for the DBS Program (7.00% per year) and the CBB Program (6.50% per year). If alternate investment returns are adopted, we recommend the assumed interest credits on these accounts be adjusted to equal the corresponding assumed investment return.

Recommendation

Our recommended assumptions are shown below.

Interest on Member Accounts		
	DB	**CBB & DBS**
Current Assumption	3.00%	7.00% (DBS) 6.50% (CBB)
Base Recommendation[1] (No change)	3.00%	7.00% (DBS) 6.50% (CBB)

1. If the investment return assumption were lowered, we would recommend a corresponding decrease in the assumed interest on the DBS and CBB Program accounts.

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5. DBS and CBB 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.

DBS and CBB Programs Standard Deviation

Under board policy, the additional earnings credits for the DBS and CBB 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 approximately 7% in 2018, and we project it will increase to around 14% 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 calculated the standard deviation to be 13.1%. This compares to the current assumption of 15.0%.

As previously discussed in the investment return section, the CBB Program assets are based on a separate allocation. We calculated that the standard deviation of the CBB Program allocation is 11.0%. This compares to the current assumption of 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 below.

Portfolio Standard Deviation		
	DBS	**CBB**
Current Assumption	15.00%	13.00%
Recommended Assumption	13.10%	11.00%

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3. Actuarial Methods and Miscellaneous Assumptions

Actuarial Standard of Practice (ASOP) No. 4, Measuring Pension Obligations and Determining Pension Plan Costs and Contributions, provides guidance to actuaries giving advice on selecting actuarial methods for defined benefit plans. Actuarial Standard of Practice (ASOP) No. 44, Selection and Use of Asset Valuation Methods for Pension Valuations, provides guidance on methods for recognizing investment gains and losses through the asset valuation method. As part of the current experience analysis, we reviewed the valuation methods and other issues related to the actuarial assumptions in the context of these ASOPs. 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 in the special cases 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 ongoing portion of the DB Program. We are recommending a technical modification to the way the method is applied. Under the current method, the Normal Cost rate for members who selected Coverage A death benefits is based on the Normal Cost rate for the 2% at 60 group with Coverage B death benefits. Therefore, the Normal Cost rate for members with Coverage A is not based on their own demographics. It is then applied to the total 2% at 60 payroll and future payroll to determine the Normal Cost and Present Value of Future Normal Costs, respectively, for the group. That is, the Normal Cost rate for Coverage A is not separately determined, but based on the rate for 2% at 60 members with Coverage B. The proposed approach would calculate Normal Costs and Present Value of Normal Costs for each individual based on their specific benefit provisions and sum the results with no adjustment. As shown in the Financial Impact subsection of the Executive Summary, the proposed actuarial method changes do not have a significant impact on the expected valuation results. The Normal Cost rate for 2% at 62 members would continue to be reported separately. The proposed modification would be consistent with the method used to calculate the Normal Cost under GASB 67/68 for financial reporting purposes.

DB Program – Pre-2014 Benefits

For the actuarial obligation allocated to service earned prior to July 1, 2014, the Projected Unit Credit (PUC) Cost Method is used. Under the PUC cost method, the actuarial present value of projected benefits for each individual member included in the valuation is determined based on the current service (in this case credited service as of June 30, 2014) and compensation projected to the age the member leaves active employment. The Normal Cost is $0 since no benefits are being earned. We believe this continues to be the appropriate cost method to determine the actuarial obligation for benefits earned prior to July 1, 2014 for both the current benefit structure and the 1990 Benefit Structure.

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DBS and CBB Programs

The cost method used for the DBS and CBB 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 DBS and CBB 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 DBS and CBB 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 DBS and CBB 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.

MPP Program

The cost method used for the MPP Program valuation is the Entry Age Normal Cost Method. Since there are no active members eligible to receive future MPP Program benefits, the Normal Cost is $0, and 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 recognize short-term fluctuations in the fair value of assets over a period of time.

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 annual 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.

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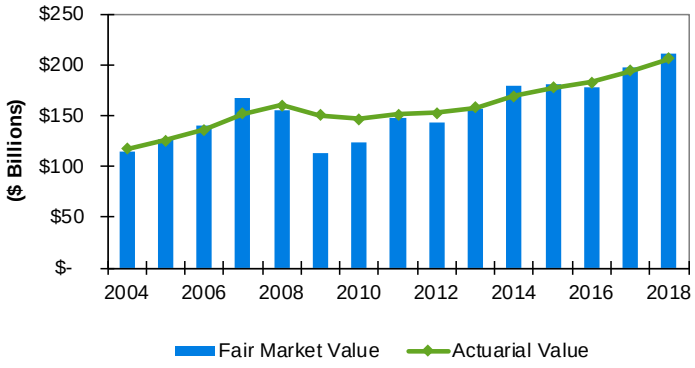
The following chart shows a history of the Actuarial Value of Assets compared to the Fair Market Value of Assets.



Asset smoothing is a valuable tool for addressing contribution volatility. 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. One concern is that a more rapid recognition (1/3rd recognition is quicker than what most public plans use) could lead to significant year-to-year contribution rate volatility. However, the caps on the state and employer contribution rate increases also mitigate the potential year-to-year contribution rate volatility. Given these caps on how much the state and employer contribution rates can change in a given year, we analyzed moving to Fair Market Value (i.e., no smoothing). We found that the smoothing reduces the year-to-year contribution rate volatility (primarily for the state) and it is not expected to negatively impact future Funded Ratios. Therefore, our recommendation is to retain the current method with one modification, as described in the following paragraph.

The financial statements provided by CalSTRS include a liability to reflect "Net Pension and OPEB Obligation." This liability reflects GASB 68 and 75 obligations for benefits provided to CalSTRS staff through CalPERS. The contributions CalSTRS makes to CalPERS to fund these benefit payments are reflected in the CalSTRS financial statements each year in the administrative expenses. Since there already is an assumption for future administrative expenses that is reflected by a reduction in the investment return assumption, these future obligations are already accounted for in the funding valuation. Therefore, we recommend excluding the Net Pension and OPEB Obligation, along with associated deferred inflows and outflows of resources, from the assets used in the funding valuation. Note that we are not recommending any changes to the way the assets are reported in the financial statements.

Valuation of Assets (DBS and CBB 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, but include the same adjustment to the Fair Market Value as the DB Program to exclude the "Net Pension and OPEB Obligation."

Valuation of Assets (MPP Program)

The assets in the THBF are valued at Fair Market Value. We recommend this method be continued, but include the same adjustment to the Fair Market Value as the DB Program to exclude the "Net Pension and OPEB Obligation."

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Miscellaneous Assumptions (Proposed assumptions are shown in Table A-1.8)

Valuation of Current Inactive Members: The valuation data provided for inactive members (members who have left active service but have not yet commenced receiving their benefit) does not include salary information. To estimate the projected retirement benefits, the inactive members' earnable salary information is retrieved from the active data in the year they were most recently active. For those we cannot locate on the active data, their compensation is based on the average active compensation in the year the member terminated. Using the compensation information along with the age and service data, an estimated benefit is included in the actuarial valuation. We performed an analysis on service retirements from inactive status during the year ended June 30, 2018 and found that actual benefit amounts were 97% of the estimated amount, so we believe our current method is providing a reasonable estimate of the benefit amount. Therefore, we are recommending no change to this method. More details on this calculation are provided in Appendix A-1.

Inactive Member Retirement Age: We 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 60.8. Note these are essentially all 2% at 60 members. Our current assumption is age 60 for 2% at 60 members and age 62 for 2% at 62 members. Although the actual experience for 2% at 60 members is closer to 61, it is somewhat inflated due to later retirements (after age 65). There is not sufficient data to analyze retirement from inactive status for the 2% at 62 members. We are recommending retaining the current assumptions.

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	Base Recommendation
Male	0.61	0.65	0.65
Female	0.54	0.50	0.50

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 very low. This is similar to findings from the prior study. Our analysis showed only 9 total members were having offsets applied to their benefits and the average offset was only 0.2% of final average compensation. Our recommendation is to continue to assume no offsets for future death and disability benefits, but continue to value the offsets as they actually occur.

Probability of Eligible Survivor for Active Death Benefit: 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 85% of males and 65% of females will have an eligible survivor. Members who die during active employment with an eligible beneficiary who elects the annuity benefit are not reported separately from those who die without an eligible beneficiary. Therefore, we are unable to perform a statistically valid study of this assumption. To assess the reasonableness of this assumption, we looked at other public retirement systems in California and other teacher retirement systems across the country, and based on this analysis we believe the current assumption is reasonable. We are recommending retaining the assumption.

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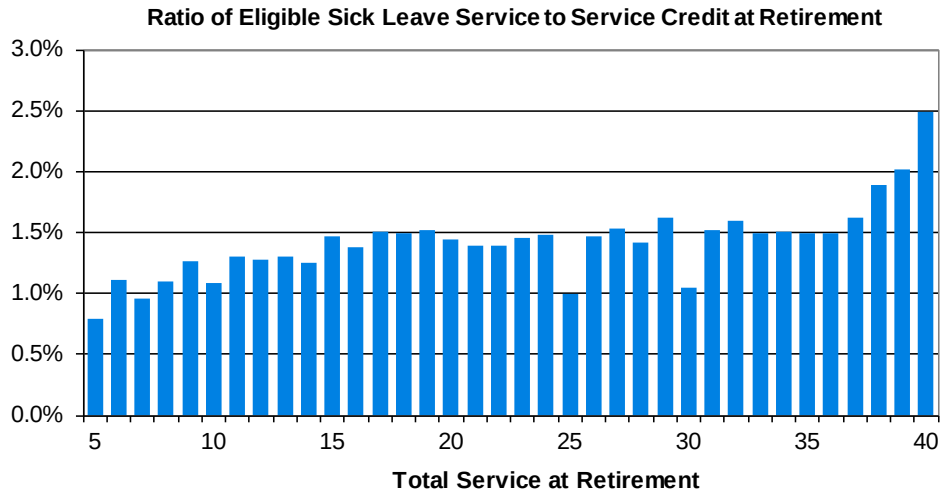
Sick Leave Load: We have studied the unused sick leave for those members who retired during the study period. We found that this service was generally proportional to credited service. On average, new retirees had 0.36 years of unused sick leave service and 24.5 years of credited service (including unused sick leave service). This implies that sick leave service is approximately 1.49% of non-sick leave credited service. Given the prior five-year study showed a higher percentage, we only gave partial credibility to this experience.
The current assumption is a 1.8% load on credited service to account for future sick leave service; we recommend adjusting this to 1.7% to partially reflect the recent experience. The following graph shows the results of our study.



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. Note that we are not recommending these changes in our base assumptions.

Additionally, CalSTRS makes assumptions specific to the option factor, as discussed below. 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	144%	175%	140%
2nd	131%	140%	120%
3rd	107%	120%	100%
4th	77%	105%	100%
Female Mortality			
1st	168%	350%	250%
2nd	188%	180%	160%
3rd	130%	150%	130%
4th	81%	115%	100%

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Members who elect continuance benefits tend to have a higher proportion of male members than the general population. We are recommending reductions in the assumptions used in the calculation of the blended mortality rate for the optional factors. Note that for options 2, 3, 4 & 5 there was not statistically sufficient data to recommend a change.

	Male Percentage		
Option	Actual	Expected	Proposed
2	77.8%	80%	No Change
3	36.4%	55%	No Change
4	66.7%	75%	No Change
5	n/a	70%	No Change
6	47.2%	50%	No Change
7	28.1%	30%	No Change
8	36.8%	n/a	No Change
9	39.9%	45%	40%

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 29.6% of the total benefit amounts.

With generational mortality, mortality rates by age 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 continue with the current simplification, that is, to change the mortality tables used for the option factors only following each experience study, instead of every year. With this option, full generational mortality tables are used based on the birth year for a member retiring at age 60 at the midpoint of the period the options factors would apply. For example, if the option factors were to apply to 2020-2024, full generational projection would apply to the mortality tables based on a fixed retirement year of 2022 and a 1962 birth year (mid-point of period of 2022, less assumed retirement of age 60). Note that the mortality projection scale is discussed in Section 5.

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, so an assumption is required. The current assumption estimates the impact of using one-year compensation on a year-by-year basis. We reviewed this assumption on both a count-weighted and service-weighted basis, and the results were consistent between the two methods. We recommend continuing to use this assumption, with updates for the last three years.

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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%
2017	8,116	7,798	4.1%
2018	8,349	8,146	2.5%

Note: 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 2018, 4.3% is used. The 4.3% represents the assumed 3.5% general wage growth assumption plus 0.8% for merit. If an alternative general wage growth assumption is adopted, the 4.3% should be adjusted to reflect this. We recommend this table be updated with each following experience analysis study.

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4. Salary Increases Due to Promotion and Longevity (Merit)

Results

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.

In Section 2, we discuss the second of these rates, the general wage inflation. Our base recommendation is to retain the current assumption of 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 study period. Isolating the general wage growth and merit increases accurately over short periods can be difficult, so we use a longer period for the merit increase study by combining the last four experience studies. The observed general wage growth over the 16-year study period is 2.28%.

Exhibit 4-1 shows the actual merit increases in salary over the period July 1, 2002 – June 30, 2018. Increases were higher earlier in a member's career (lower service) and then decreased over time, consistent with the current assumptions. The actual increases were close to those predicted by the current assumptions over all service levels. Note that when we calculate the merit salary increase at different service levels, we use elapsed service. For example, if a member hired 10 years ago and worked half-time during that period, our analysis would use 10 years of service, not the five years of credited service they would have accrued.

The current merit salary assumptions are separated by entry age. Exhibit 4-2 shows the average increases by entry age group. This exhibit illustrates the 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, consistent with the current assumptions.

Recommendation

Based on the results of the prior two experience studies, we are recommending no change to the merit increase assumption. The proposed rates are shown in Table A-1.7.

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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)

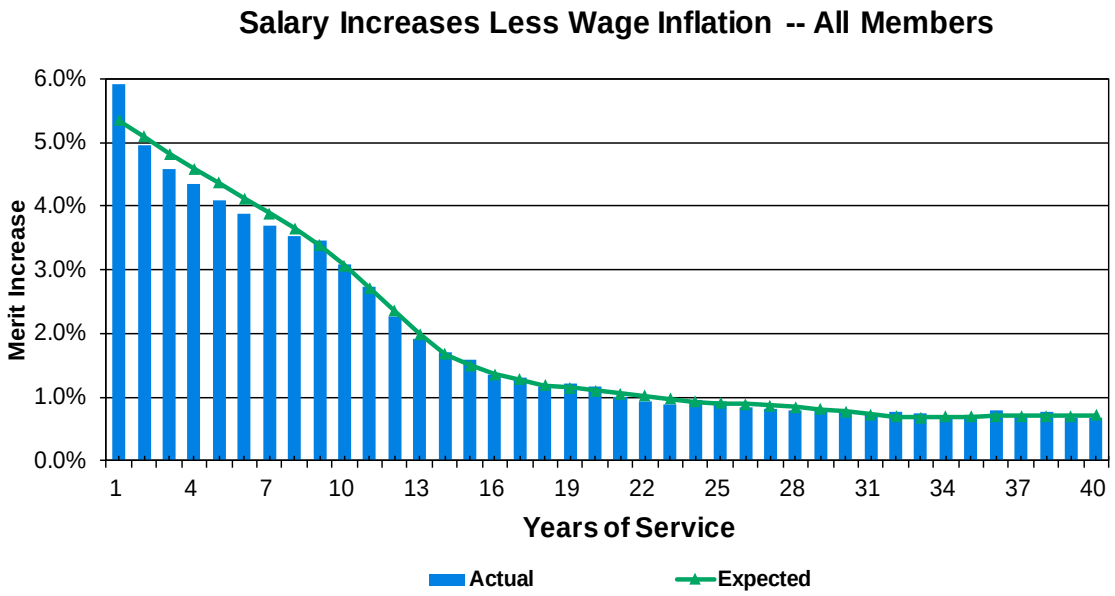
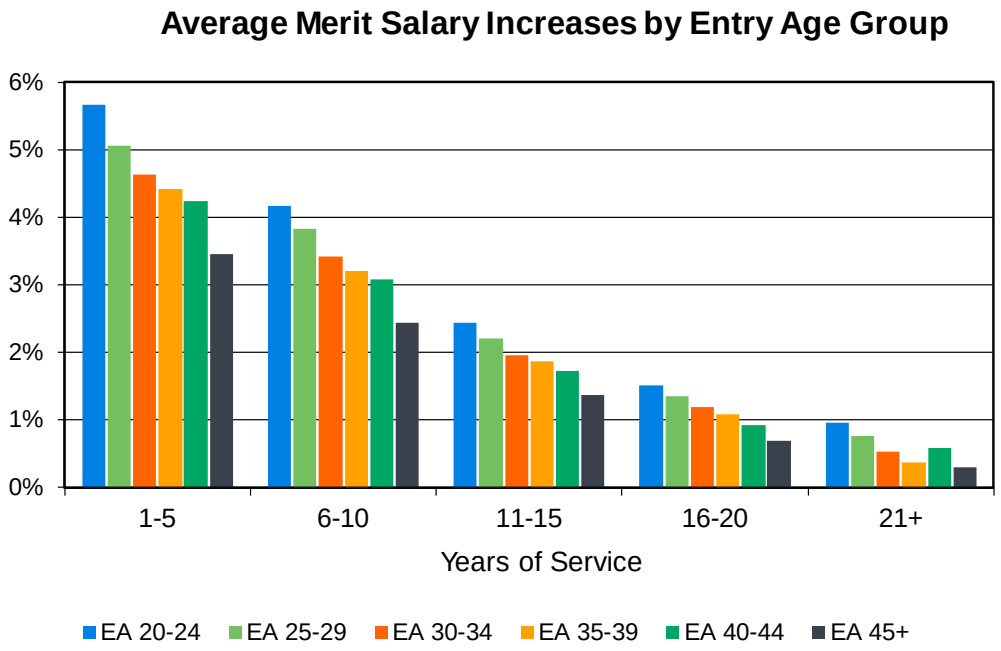


Exhibit 4-2
Annual Rates of Increase in Salary by Entry Age Due to Merit and Longevity

(Excluding Actual General Wage Growth)



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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.

Like most public sector retirement systems, generational mortality is used in the CalSTRS actuarial valuation to reflect expected improvements in mortality. Generational mortality is reflected by including a mortality improvement scale that projects small annual decreases in the base mortality rates. The Actuarial Standards of Practice require expected future mortality improvements to be considered in selecting the assumption. We believe the current projection scale used in the CalSTRS valuation reasonably reflects expected future improvements in mortality.

Results

Overall, we found the number of deaths over the study period for retirees and beneficiaries was very close to the number predicted by the current rates: 23,845 actual deaths, compared to 22,408 expected deaths for a total actual/expected ratio of 106%. In general, we recommend 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. That is the case with the results of this study.

In our experience studying the mortality of public pension plan retirees, we have consistently found that retirees with larger benefits tend to live 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%).

The following shows a summary of the results of the study. Detailed results are shown graphically later in this Section.

	Actual to Expected (Count-Weighted)		
Status	Actual	Expected	A/E Ratio
Healthy Male	8,168	7,641	107%
Healthy Female	11,366	10,713	106%
Healthy Total	19,534	18,354	106%
Disabled Male	303	285	106%
Disabled Female	650	606	107%
Disabled Total	953	891	107%
Beneficiary Male	878	858	102%
Beneficiary Female	2,480	2,305	108%
Beneficiary Total	3,358	3,163	106%
Grand Total	**23,845**	**22,408**	**106%**

Note: Results are presented on a count-weighted basis. On a benefit-weighted basis, the Actual/Expected ratio is approximately 102%.

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New Public Plan-Specific Mortality Tables

In 2019, the Society of Actuaries published new mortality tables based on data from public sector retirement systems. In particular, tables specific to retired teachers were included. We compared how well the current CalSTRS custom mortality tables and the new teacher-specific mortality table (PubT.H-2010) matched the actual experience. Based on our analysis, we found that both tables matched closely with the experience, with the current tables having a slightly better match. At this point, we are not recommending a change to the new tables, but we will continue to monitor this in future studies.

Generational Mortality Tables

Like CalSTRS, most public plan actuarial valuations 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 primary benefits of generational mortality tables is the valuation assumptions should effectively update each year to reflect improved mortality, so that the base tables should not need to be updated as often.

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-2019) goes to a flat 1% annual improvement in years 2032 and later for ages 85 or less.

The current projection scale assumption is 110% of the ultimate portion of the MP-2016 scale. In other words, it assumes 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 the current 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 current 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 believe the current base mortality tables combined with the current projection scale provides for a reasonable expectation of future life expectancy and are recommending no changes to this assumption.

Although there have been no changes to the ultimate mortality projection scale, we recommend updating the projection scale from 110% of MP-2016 Ultimate to 110% of MP-2019 Ultimate to provide a more current date.

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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. Note that for beneficiaries of healthy and disabled retirees, the mortality for healthy retirees is used, as observed experience continues to show a significant amount of consistency between retirees and beneficiaries.

The proposed rates are shown in Table A-1.2. Rates of mortality among active members prior to retirement are discussed separately in Section 6 of this report.

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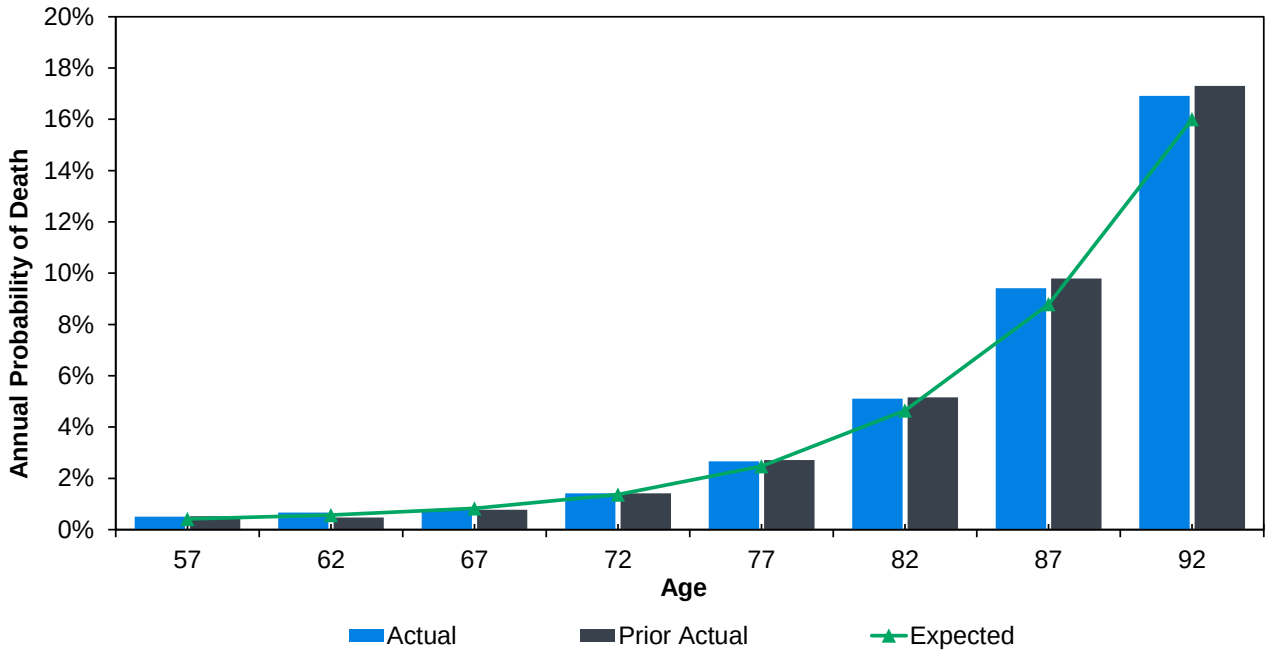
Exhibit 5-1
Mortality for Service (Healthy) Retirees – Males



All Ages

	Expected	Actual	Proposed
Total Count Actual / Expected	7,641 107%	8,168	No Change

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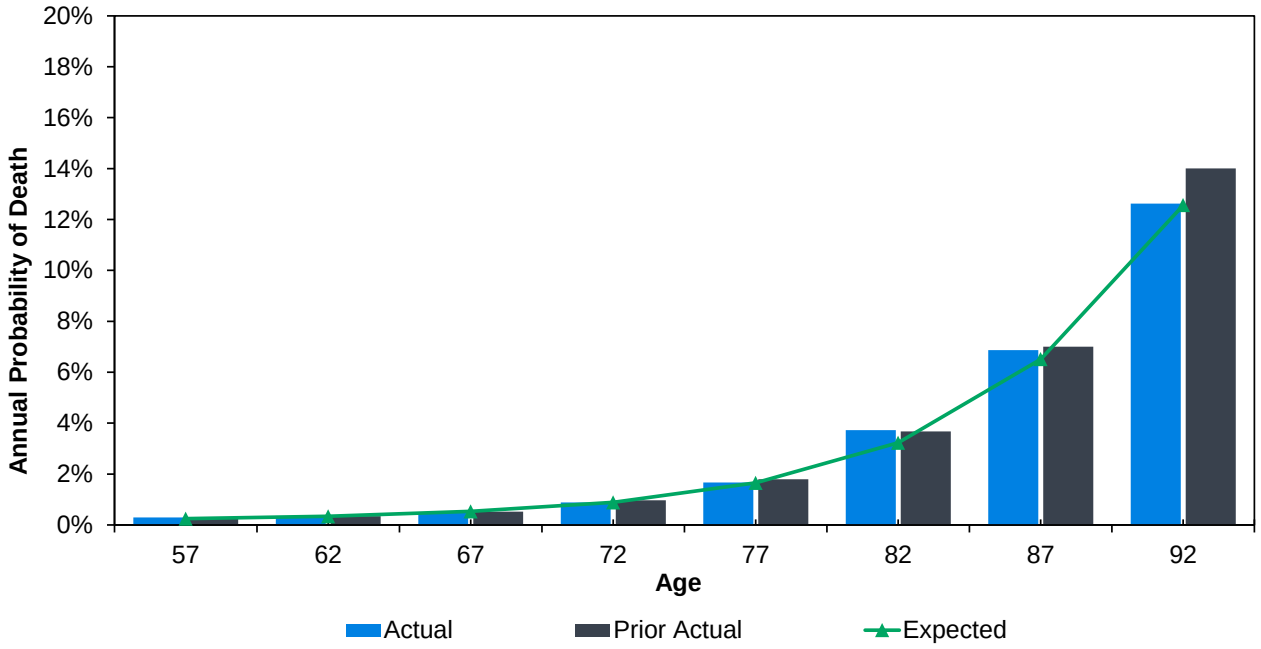
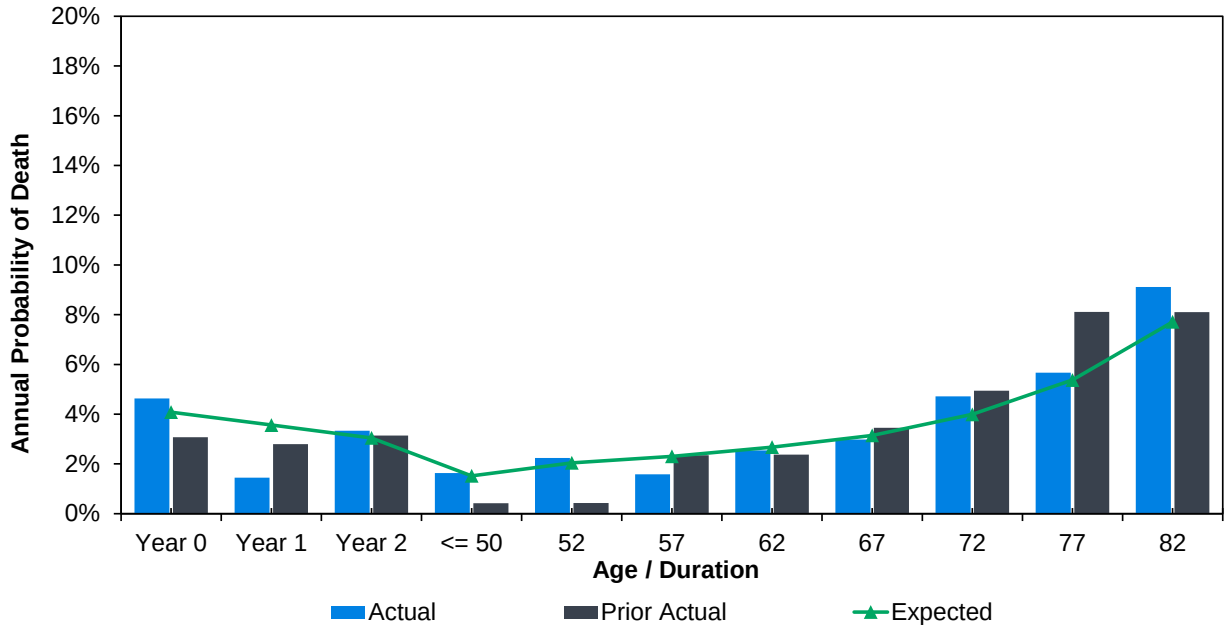
Exhibit 5-2
Mortality for Service (Healthy) Retirees – Females



All Ages

	Expected	Actual	Proposed
Total Count	10,713	11,366	No
Actual / Expected	106%		Change

Exhibit 5-3
Mortality for Disabled Retirees – Males



All Ages

	Expected	Actual	Proposed
Total Count	285	303	No
Actual / Expected	106%		Change

First Three Years of Retirement

	Expected	Actual	Proposed
Total Count	44	39	No
Actual / Expected	88%		Change

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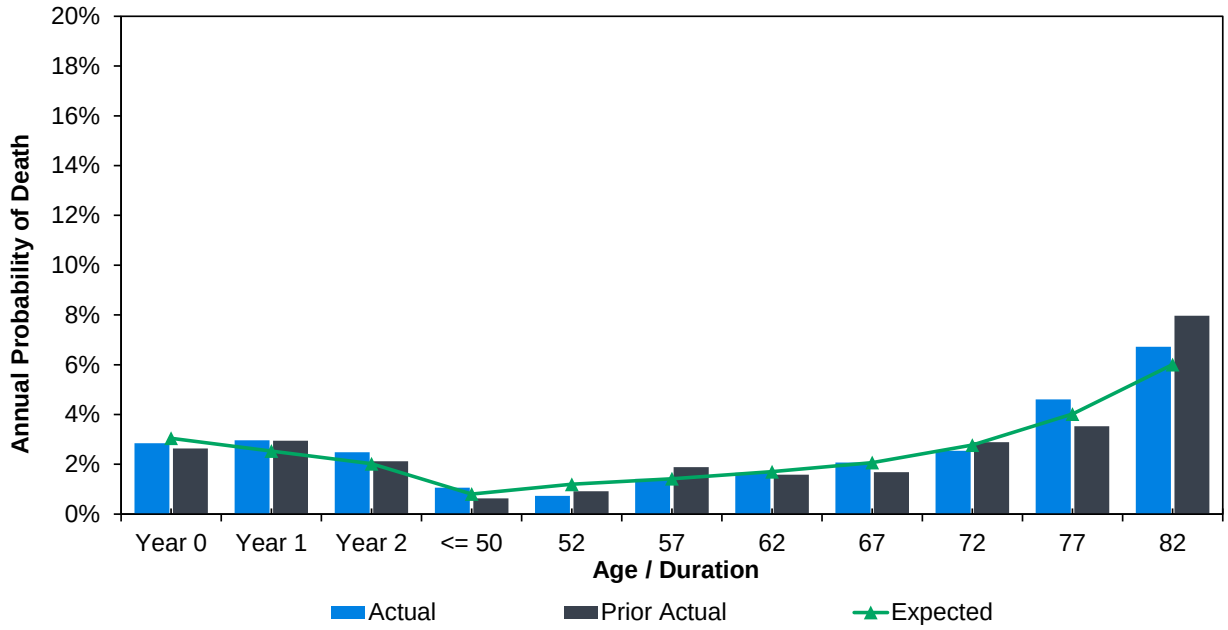
Exhibit 5-4
Mortality for Disabled Retirees – Females



All Ages

	Expected	Actual	Proposed
Total Count	606	650	No
Actual / Expected	107%		Change

First Three Years of Retirement

	Expected	Actual	Proposed
Total Count	104	114	No
Actual / Expected	109%		Change

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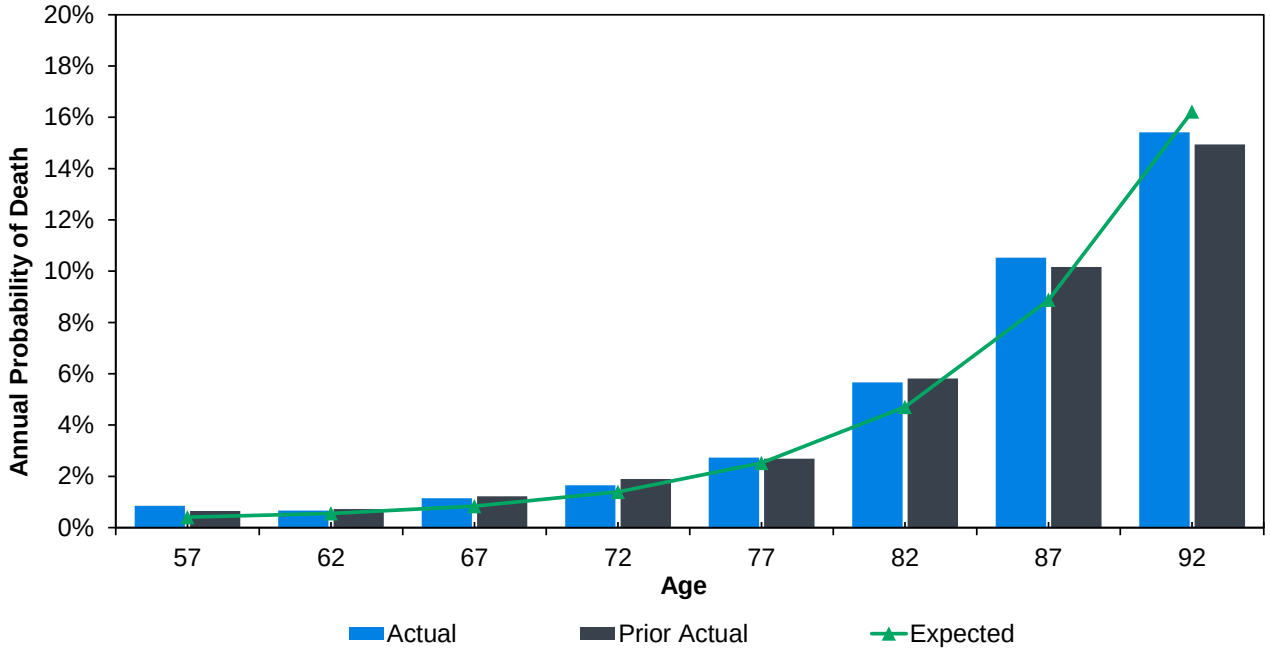
Exhibit 5-5
Mortality for Beneficiaries – Males



All Ages

	Expected	Actual	Proposed
Total Count Actual / Expected	858 102%	878	No Change

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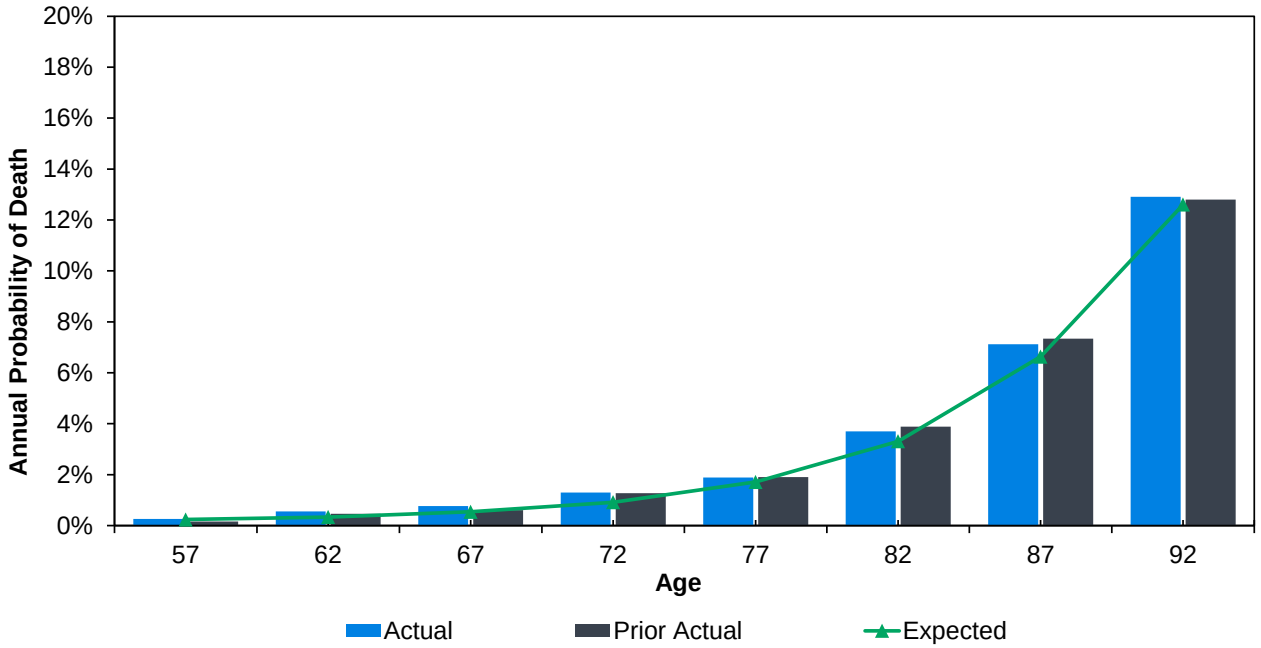
Exhibit 5-6
Mortality for Beneficiaries – Females



All Ages

	Expected	Actual	Proposed
Total Count	2,305	2,480	No
Actual / Expected	108%		Change

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.

Results

The number of active deaths was slightly less than expected, with an actual-to-expected ratio of 92%. The proposed rates reduce the rates to be in line with the actual experience.

	Actual to Expected			Actual to Proposed		
Status	Actual	Expected	A/E Ratio	Actual	Proposed	A/P Ratio
Active Male	474	502	94%	474	457	104%
Active Female	648	722	90%	648	625	104%
Active Total	1,122	1,224	92%	1,122	1,082	104%

Note that this analysis is on a head-count weighted basis.

Recommendation

We recommend new custom tables be adopted based on CalSTRS mortality experience for active members. Note that the results shown above are based on a head-count weighted basis. The recommended tables are adjusted to reflect the comparable benefit-weighted tables. All proposed tables use 110% of the MP-2019 Ultimate Projection Scale applied generationally. The proposed rates are shown in Table A-1.2.

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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 based on an individual member's years of credited service. Therefore, we performed analysis of service retirement by age for the following 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. Thirty 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

We also performed additional analysis by years of service within those groups.

Results

For members with less than 30 years of service, the total actual retirements from active service was greater than what the assumptions predicted. For members with more than 30 years of service, it was 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	15,362	14,153	109%
25 to 30 Years of Service	6,920	6,344	109%
30 Years or More of Service	11,010	12,064	91%
Total	33,292	32,561	102%

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

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service have a higher probability of retirement; however, we would not expect the differences at 25 and 30 years of service to be as significant.

Recommendation: 2% at 60 Members

We are recommending increases to the retirement rates for members with less than 30 of years of service to better fit the observed patterns. For members with 30 or more years of service, we are recommending a decrease in the retirement rates since the actual rates were less than the expected rates.

For this study, we have broken down the assumption and set retirement rates based on five-year bands of service with additional breakpoints for those with over 25 years of service. Specifically, a separate set of rates is assumed for members with 5-9 years of service, 10-14 years of service, 15-19 years of service, 20-24 years of service, 25 years of service, 26-29 years of service, 30 years of service, and 31 or more years of service. We found that this breakdown better reflected the actual experience. The proposed rates are shown in Tables A-1.3a to A-1.3b.

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 proposed 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	15,362	14,754	104%
25 to 30 Years of Service	6,920	6,826	101%
30 Years or More of Service	11,010	11,474	96%
Total	33,292	33,054	101%

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. We have recommended revised rates for 2% at 62 members with similar patterns as those for 2% at 60 members. We developed separate retirement rates based on the member's credited years of service. Specifically, a separate set of rates is assumed for members with 5-9 years of service, 10-14 years of service, 15-19 years of service, 20-24 years of service, 25-29 years of service, and 30 or more years of service. The proposed rates are shown in Tables A-1.3c to A-1.3d.

Recommendation: 1990 Structure

The current service retirement rates for calculations under the 1990 Structure are based on the experience prior to 2001 when the 1990 Structure benefit provisions applied. We continue to believe that maintaining separate retirement rates for the 1990 Structure benefits is appropriate; however, we are recommending modifying the current rates, which are based solely on age, to reflect the impact of credited service to be consistent with the other service retirement assumptions. We developed separate retirement rates based on the member's years of service that result in approximately the same expected number of retirements, but have higher rates at higher levels of service (and lower rates at lower levels of service). Specifically, a separate set of rates is assumed for members with 5-9 years of service, 10-14 years of service, 15-19 years of service, 20-24 years of service, 25-29 years of service, and 30 or more years of service. The proposed rates are shown in Tables A-1.3e to A-1.3f.

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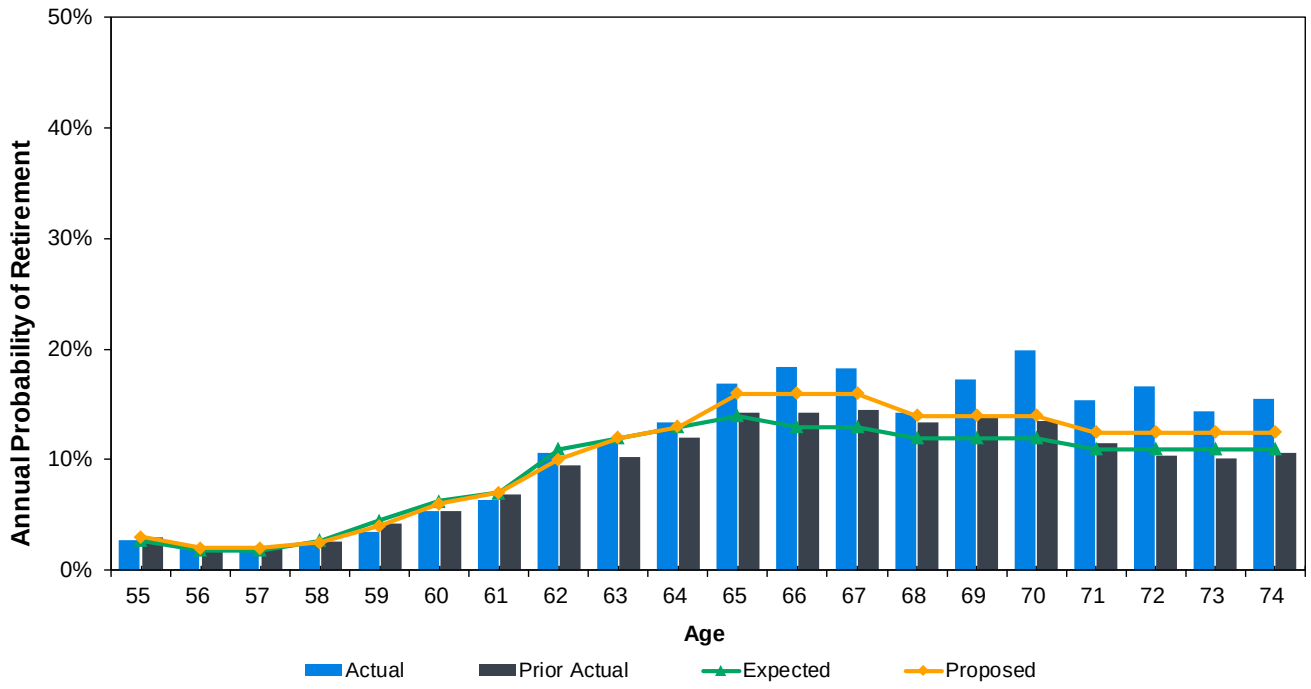
Exhibit 7-1
Service Retirement Rates (2% at 60 Members)
Males – Less than 25 Years of Service



Service Retirement Summary (Ages 55-74)

<25 Years of Svc	Expected	Actual	Proposed
Total Count	3,684	4,107	3,900
Actual / Expected	111%		105%

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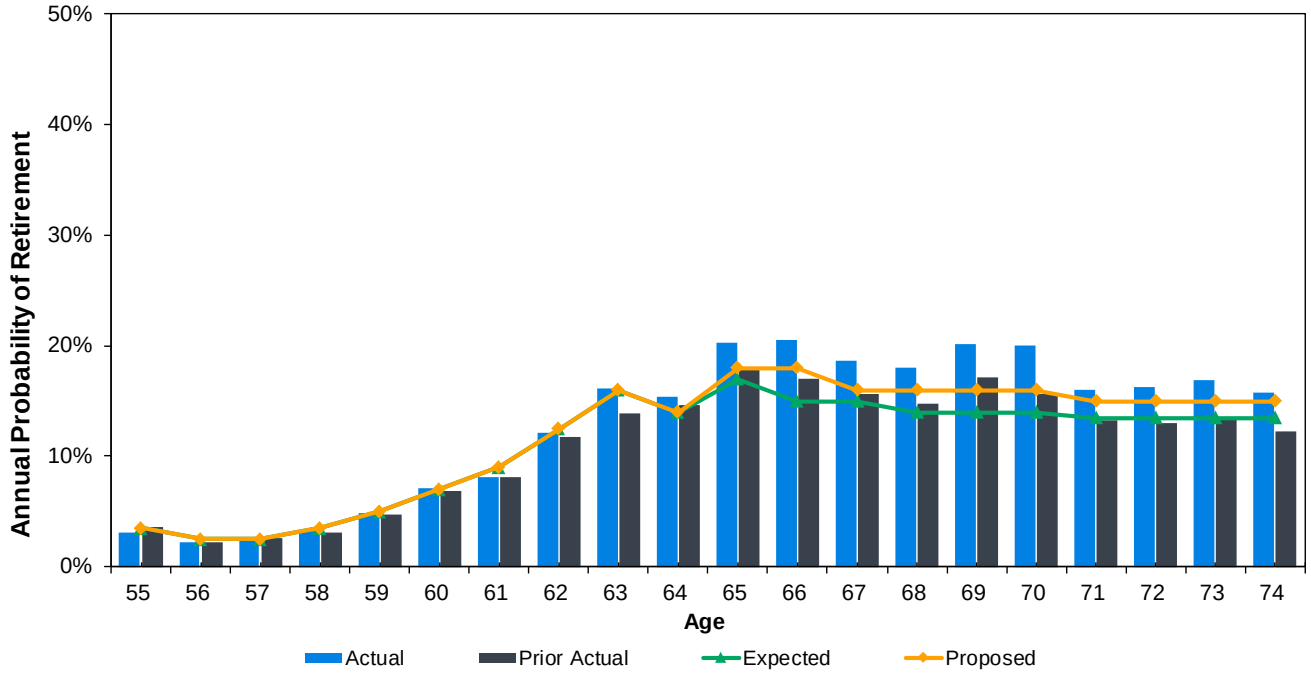
Exhibit 7-2
Service Retirement Rates (2% at 60 Members)
Females – Less than 25 Years of Service



Service Retirement Summary (Ages 55-74)

<25 Years of Svc	Expected	Actual	Proposed
Total Count	10,469	11,255	10,854
Actual / Expected	108%		104%

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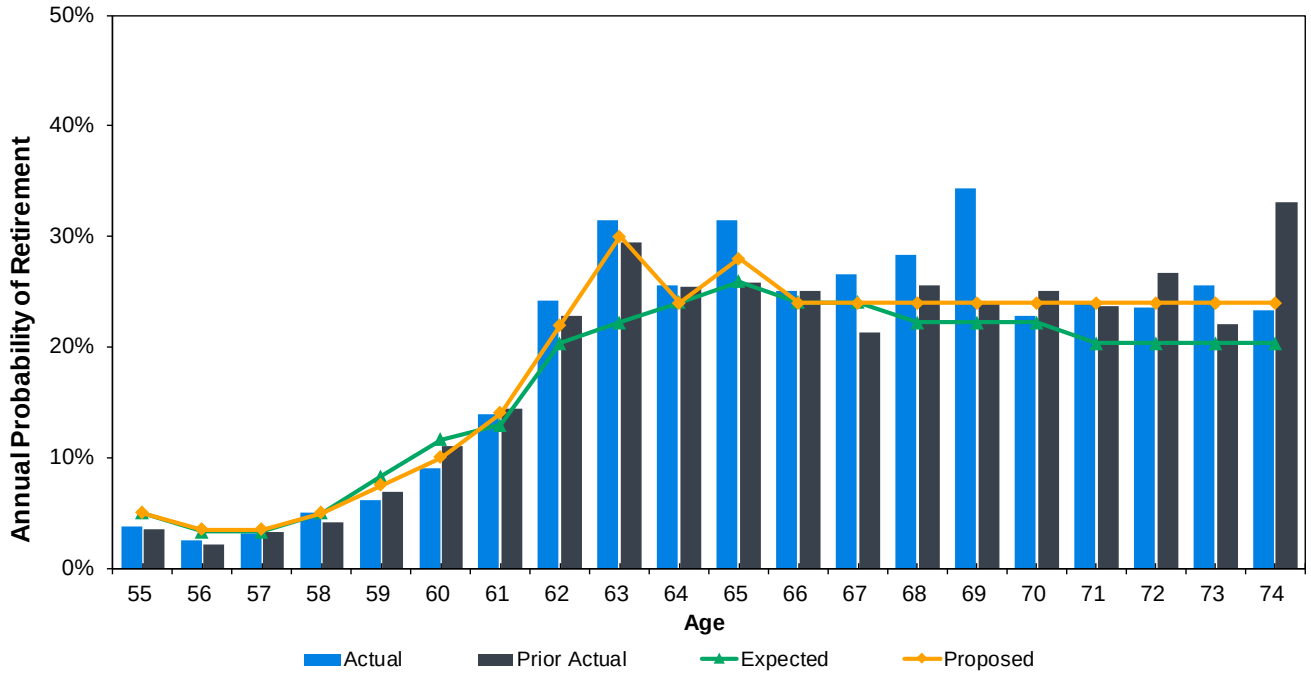
Exhibit 7-3
Service Retirement Rates (2% at 60 Members)
Males – 25 to 30 Years of Service



Service Retirement Summary (Ages 55-74)

25 to 30 Years of Svc	Expected	Actual	Proposed
Total Count	1,709	1,845	1,812
Actual / Expected	108%		102%

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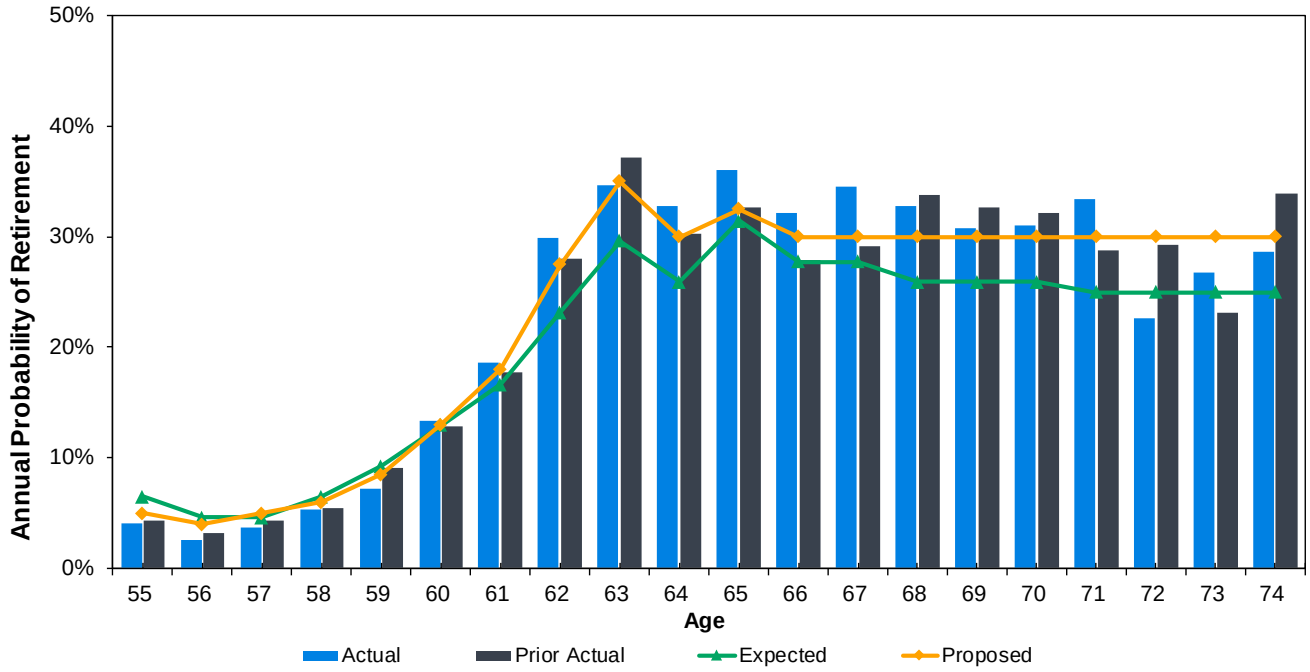
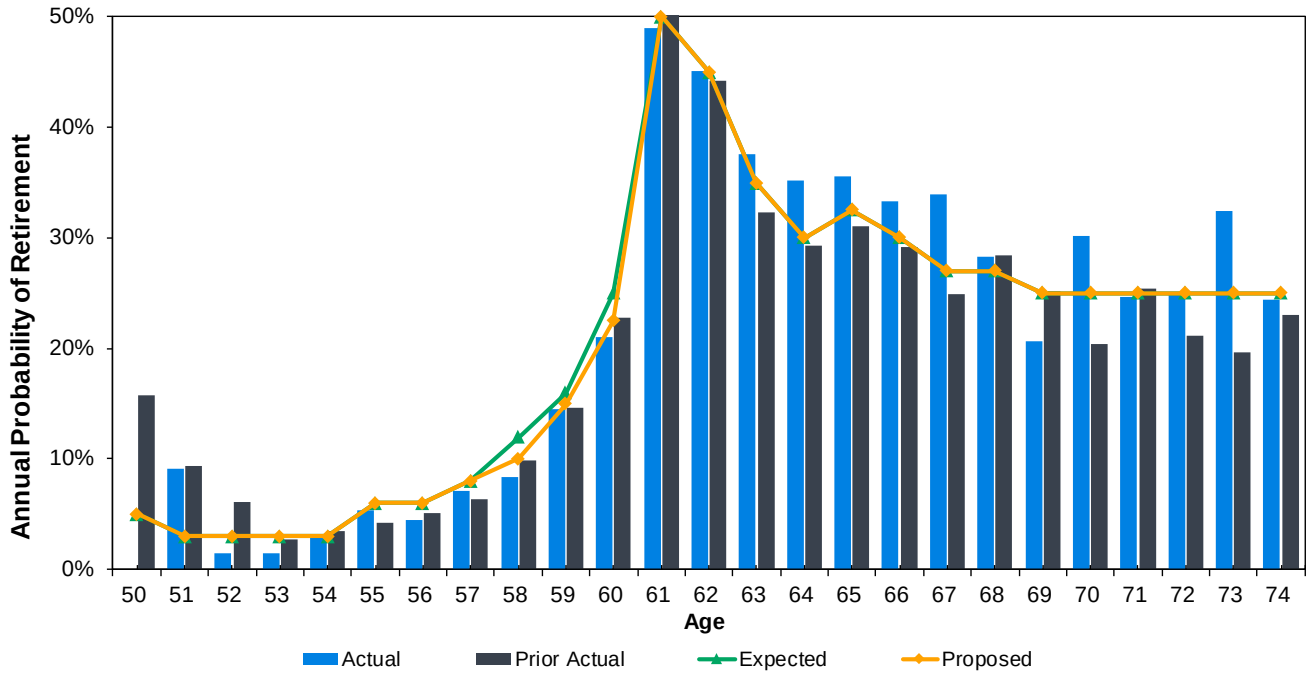
Exhibit 7-4
Service Retirement Rates (2% at 60 Members)
Females – 25 to 30 Years of Service



Service Retirement Summary (Ages 55-74)

25 to 30 Years of Svc	Expected	Actual	Proposed
Total Count	4,635	5,075	5,014
Actual / Expected	109%		101%

Exhibit 7-5
Service Retirement Rates (2% at 60 Members)
Males – 30 or more Years of Service



Service Retirement Summary (Ages 50-74)

30+ Years of Svc	Expected	Actual	Proposed
Total Count	3,695	3,595	3,588
Actual / Expected	97%		100%

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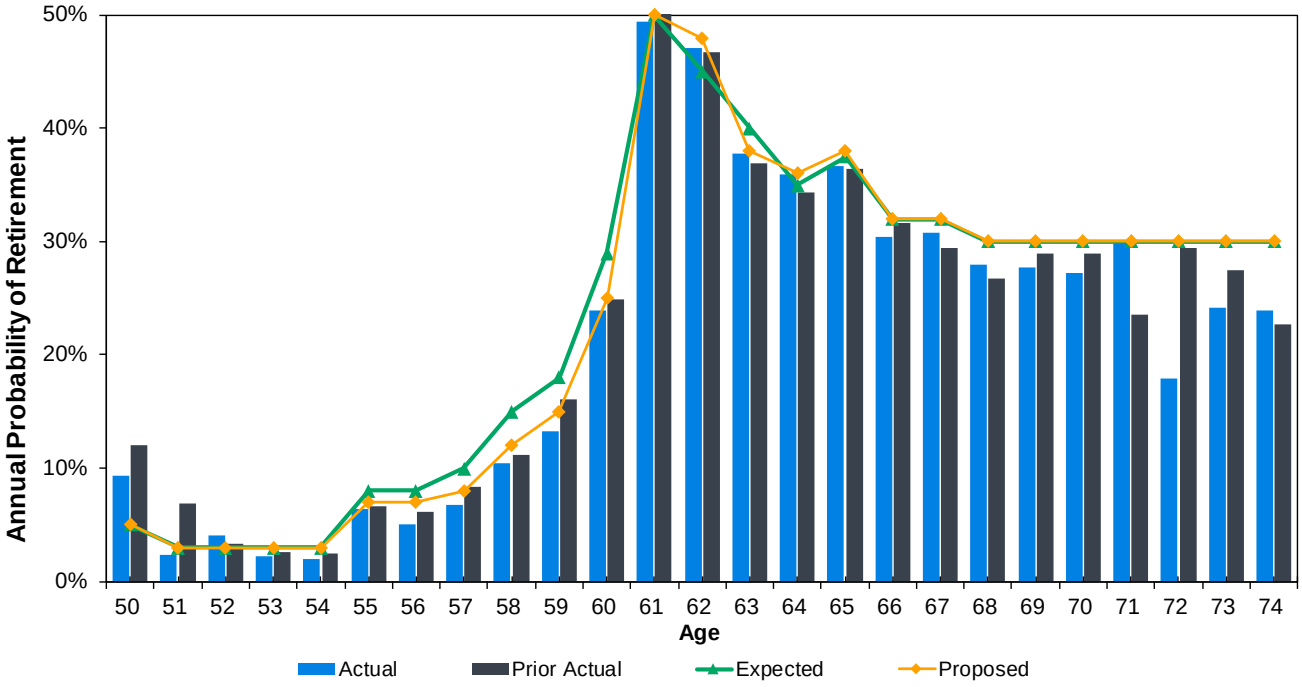
Exhibit 7-6
Service Retirement Rates (2% at 60 Members)
Females – 30 or more Years of Service



Service Retirement Summary (Ages 50-74)

30+ Years of Svc	Expected	Actual	Proposed
Total Count	8,369	7,415	7,886
Actual / Expected	89%		94%

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8. Disability Retirement

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.

Results

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	29	49	59%
Female	107	152	70%
Total	135	200	68%

Coverage B	Actual	Expected	Actual / Expected
Male	259	390	66%
Female	844	1,064	79%
Total	1,102	1,454	76%

Recommendation

We are recommending decreasing the rates of disability for Coverage A and Coverage B members. The proposed rates are shown in Table A-1.4.

Actual vs. Proposed Disability Retirements

Coverage A	Actual	Proposed	Actual / Proposed
Male	29	44	65%
Female	107	136	78%
Total	135	180	75%

Coverage B	Actual	Proposed	Actual / Proposed
Male	259	356	73%
Female	844	963	88%
Total	1,102	1,319	84%

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9. Other Terminations of Employment (Termination)

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 elapsed service (the greater the years of service, the less likely a member is to terminate employment) and gender.

Factors Affecting Termination Rates

We continue to find that service level is the single greatest factor affecting rates of termination. Reflecting this, the current assumptions are based on elapsed service (years since the member joined CalSTRS). We further analyzed terminations by credited service, which reflects actual service credited during the period and differs from elapsed service for members who have worked part-time or had a break in service. Based on this analysis, we found that members working full-time for their entire career have lower termination rates than the part-time group (i.e., those members who have less credited service than elapsed service).

We also reviewed whether age has a significant impact on termination rates at a given service level. We did not find a meaningful difference due to a member's age.

Results

Overall, the actual number of terminations was less than expected, as shown in the following table.

Actual vs. Expected Terminations[1]

	Actual	Expected	Actual / Expected
Males	7,602	8,604	88%
Females	15,567	19,870	78%
Total	23,169	28,475	81%

1. Excludes first year of service.

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.

Recommendation

The results of the study are shown in Exhibits 9-1 and 9-2 with the proposed new termination rates, which are lower than the current rates. We have recommended the reduced rates to reflect recent experience. In making this recommendation, we also considered that members working full-time for their entire career have lower termination rates than those who have worked part-time or previously had a break in their service. Since a full-time member has greater credited service than a part-time member at the same level of elapsed service, full-time members will have a relatively greater impact on the actuarial obligation. Therefore, we gave greater weight to the full-time service group who have lower rates of termination to better reflect their impact on the actuarial obligation. The following table summarizes these results. The proposed rates are shown in Table A-1.5.

Actual vs. Proposed Terminations[1]

	Actual	Proposed	Actual / Proposed
Males	7,602	7,083	107%
Females	15,567	16,025	97%
Total	23,169	23,108	100%

1. Excludes first year of service.

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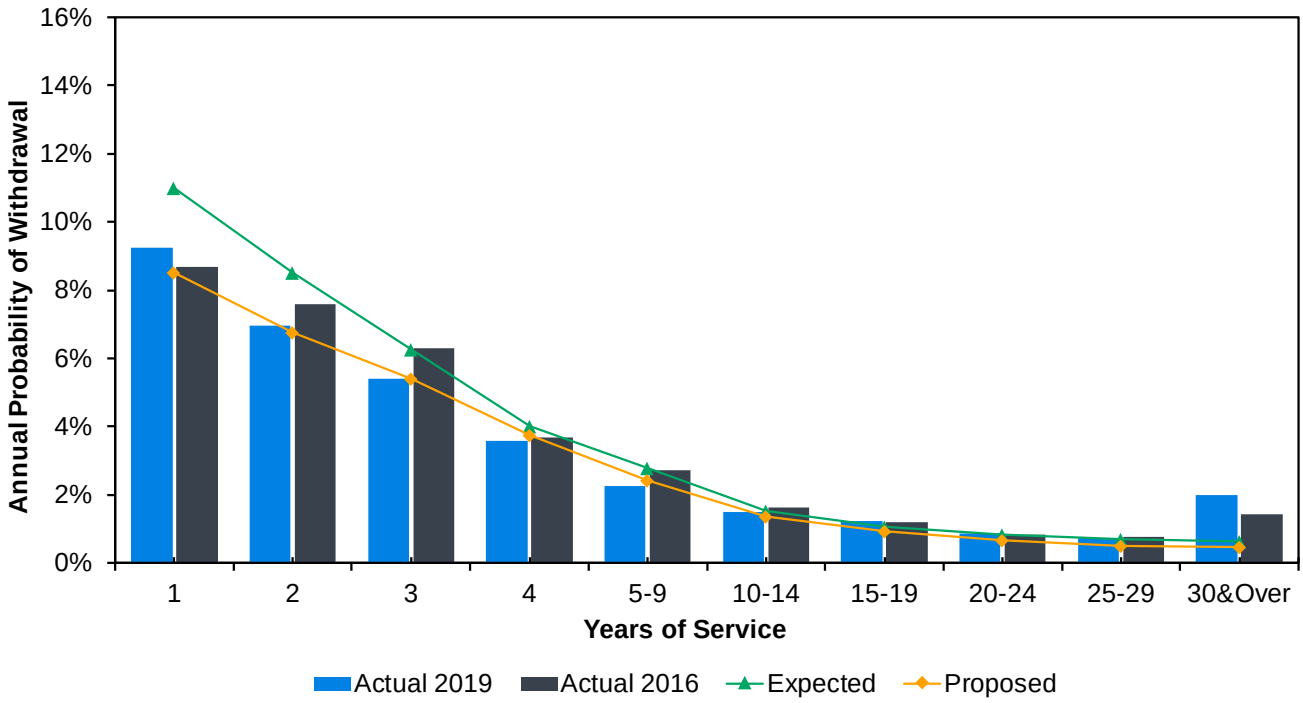
Exhibit 9-1
Termination by Years of Elapsed Service – Males[1]



	Expected	Actual	Proposed
Total Count[1]	8,604	7,602	7,083
Actual / Expected	88%		107%

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

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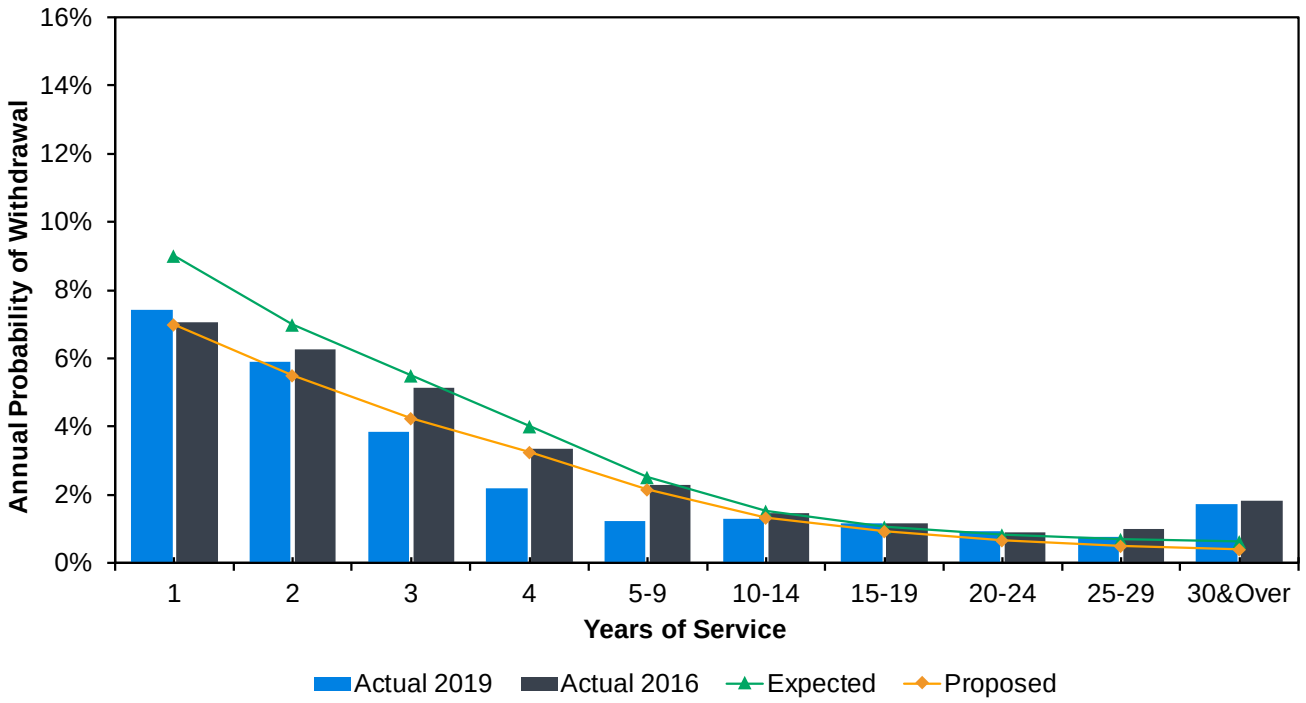
Exhibit 9-2
Termination by Years of Elapsed Service – Females[1]



	Expected	Actual	Proposed
Total Count[1]	19,870	15,567	16,025
Actual / Expected	78%		97%

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

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10. Probability of Refund Upon Vested Termination

This section of the report discusses the probabilities 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 the actual and expected number of refunds among vested members who terminated employment during the study period, split by entry age group. 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 7% less than what the assumptions predicted.

Actual to Expected Number of Refunds

Males

Entry Age	Actual	Expected	Ratio
20 - 24	24	51	47%
25 - 29	353	405	87%
30 - 34	221	260	85%
35 - 39	111	130	86%
40 - 44	51	78	66%
45 & Up	134	195	69%
Total	894	1,118	80%

Females

Entry Age	Actual	Expected	Ratio
20 - 24	197	188	105%
25 - 29	839	766	109%
30 - 34	395	379	104%
35 - 39	218	246	89%
40 - 44	106	129	82%
45 & Up	224	271	83%
Total	1,979	1,980	100%
Grand Total	2,873	3,098	93%

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Recommendation

Based on the experience, we are recommending a unisex table for the assumed rates at which members withdraw their contributions from CalSTRS. The proposed rates reflect small reductions in the overall probability of refund. The results based on the proposed assumptions are shown below. The proposed rates are shown in Table A-1.6.

Actual to Proposed Number of Refunds			
Entry Age	Actual	Proposed	Ratio
20 - 24	221	246	90%
25 - 29	1,192	1,201	99%
30 - 34	616	668	92%
35 - 39	329	354	93%
40 - 44	157	184	85%
45 & Up	358	415	86%
Total	2,873	3,068	94%

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11. Assumptions Specific to the MPP Program

This section of the report deals with the MPP Program assumptions. For purposes of this study, experience from the four-year period June 30, 2014 to June 30, 2018 was included. Table A-4.1 in Appendix A shows a summary of the current and recommended assumptions for the MPP Program.

Investment Return Assumption / Discount Rate

For the funding valuation, we recommend that CalSTRS continue to use the same investment return assumption as for the DB Program valuation to estimate the present value of the MPP Program liabilities.

For GASB 74/75 reporting, we recommend CalSTRS continue to use a municipal bond index to discount the projected MPP Program benefit payments. For this purpose, we recommend continued use of the Bond Buyer 20-Bond GO Index which consists of 20 general obligation bonds that mature in 20 years.

MPP Program Participation Rates

Tables A-4.2 and A-4.3 in Appendix A present the recommended participation (enrollment) assumptions to be used in the June 30, 2018 MPP Program valuation for both the best estimate and conservative (high cost) estimate scenarios. Based on a review of the actual enrollment experience over the last four years, we are recommending revised rates be used in the 2019 valuation. Exhibit 11-1 shows the results of our experience analysis.

Note the participation rates include a small margin for members who were not retired on June 30, 2012 but may elect in the future to backdate their retirement date under Education Code Section 24204 and potentially become eligible for benefits under the MPP Program.

Medicare Premium Trend Rates

We have also reviewed historical and predicted increases to the Medicare Part A and Part B premiums. This analysis takes into account projections from the 2019 Annual Report of the Boards of Trustees of the Federal Hospital Insurance Trust Fund and the Federal Supplementary Medical Insurance Trust Fund. Based on these projections, we recommend a trend assumption for Part A premiums that varies by year. It is approximately equivalent to assuming a fixed 4.5% increase each year. For Part B premiums, we recommend a trend assumption that varies by year. It is approximately equivalent to assuming a fixed 5.4% increase each year.

The following table shows the recommended trend rates:

Trend Assumption		
	Assumed Annual Increase	
Years[1]	Part A	Part B
2019 - 2028	4.3%	5.5%
2029 - 2038	5.0%	5.1%
2039 - 2048	4.9%	4.5%
2049 & Later	4.3%	4.4%

1. Trend rates indicate medical inflation in the specific valuation year and therefore affect the premiums for the following valuation year. For example, the projected 2020-21 premium is the 2019-20 premium increased by the assumed 2019-20 trend rate.

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Note that for the valuation year July 1, 2019 to June 30, 2020, we will use six months of the actual Part A premium rates for the calendar year 2019 ($437/month) and six months from 2020 ($458/month). Estimates for future valuation years are based on that average increased by the applicable trend assumption. We have assumed all members who retire after December 31, 2000 and participate in the MPP Program will be required to pay the full premium amount. This retains a small level of conservatism since some members may qualify for a reduced (45% reduction) Part A premium, due to their employment history or of their spouse's, which would mean reduced payments from the Program.

Similarly, for the valuation year July 1, 2019 to June 30, 2020, we will use the average of the actual Part B monthly premium rates for the calendar years 2019 ($135.50/month) and 2020 ($144.60/month). Note that we have not adjusted for retirees whose income (or joint income) exceeded the 2019 income threshold, as the Part B penalty amount paid by CalSTRS depends on the base Part B amount. Additionally, we have assumed that the participating retirees are not eligible for the "hold harmless" provision that currently may limit the Part B premium amount.

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Exhibit 11-1
Study of Actual Part A Enrollment Rates

	Enrollees	Total Retiree Lives[1]	Enrollment Percent Actual-4yr	Enrollment Percent Expected	Proposed
Under 65 retirees (retired on or after 2001)	402	21,422	1.88%	2.50%	2.00%
Under 65 retirees (retired before 2001)	1	102	0.98%	3.50%	2.00%
Over 65 retirees (not currently enrolled) at age:					
65	50	31,264	0.16%	0.60%	0.20%
66	9	48,927	0.02%	0.06%	0.02%
67	8	58,152	0.01%	0.04%	0.02%
68	7	59,515	0.01%	0.03%	0.02%
69	2	52,194	0.00%	0.03%	0.02%
70-74	14	199,186	0.01%	0.02%	0.02%
75-84[2]	12	347,992	0.00%	0.02%	0.02%
All ages	505	818,754	0.06%	0.11%	N/A

1. Includes only those retirees hired prior to April of 1986, retired prior to July 1, 2012, and attained age 65 or older during study period.
2. Ages 85 and above are assumed to have 0.00% enrollment.

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Appendix A-1 Defined Benefit Program Actuarial Methods and Assumptions

(Proposed changes for Base Recommendations 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

Entry Age Normal Cost Method:

The accruing costs of all benefits with future accruals are measured by the Entry Age Normal 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 Cost Method.

The projected revenue in excess of the Normal Cost rate is tested for sufficiency to amortize the Unfunded Actuarial Obligation calculated under 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.

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. The Normal Cost is based on the respective benefit structures. For projection purposes, the Normal Cost rate is assumed to increase by a relative 0.12% per year to reflect an assumed gradual increase in life expectancies due to generational mortality. 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 Credit (PUC) 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 smoothing is applied on the total DB Program assets and then the SBMA is deducted to determine the net actuarial value for funding purposes. The Fair Market Value excludes the liability for "Net Pension and OPEB Obligation," which are pre-recognized administrative expenses, from the Fiduciary Net Position reported for accounting purposes.

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-1.1** and illustrated at selected ages and duration combinations in **Tables A-1.2 – A-1.7**.

Payroll Growth Assumption

The wage growth assumption is equal to 3.50% and the active population is assumed to be stable. Thus, the DB Program payroll is assumed to increase at a rate of 3.50% each year.

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Table A-1.1
List of Major Valuation Assumptions

Economic Assumptions	
Investment Return (net of investment and administrative expenses)	7.00%
Interest on Member Accounts	3.00%
Wage Growth	3.50%
Inflation	2.75%

Demographic Assumptions		
Mortality[1]		
Active - Male	2019 CalSTRS Active Member Male	Table A-1.2
Active - Female	2019 CalSTRS Active Member Female	Table A-1.2
Retired & Beneficiary - Male	2019 CalSTRS Service Retired Male[2]	Table A-1.2
Retired & Beneficiary - Female	2019 CalSTRS Service Retired Female[2]	Table A-1.2
Disabled - Male	2019 CalSTRS Disabled Retiree Male[2]	Table A-1.2
Disabled - Female	2019 CalSTRS Disabled Retiree Female[2] (select rates in first three years for both Males and Females)	Table A-1.2
Service Retirement		Table A-1.3
Disability Retirement		Table A-1.4
Withdrawal		Table A-1.5
Probability of Refund		Table A-1.6
Merit Salary Increases		Table A-1.7
Supplemental Assumptions		Table A-1.8

1. The mortality assumption uses a generational mortality approach with a base year of 2019. Projected improvement is based on 110% of the MP-2019 Ultimate Projection Scale. The combined base tables and projection scale specified contain a margin for expected future mortality improvement.

2. The 2019 retired, disabled and beneficiary mortality tables have not changed from the prior tables, except they have been projected forward to 2019 with mortality improvement.

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Table A-1.2
Mortality as of June 30, 2019

	Active Members[1]	
Age	Male	Female
25	0.012%	0.007%
30	0.017	0.011
35	0.023	0.015
40	0.032	0.024
45	0.052	0.037
50	0.085	0.056
55	0.132	0.082
60	0.203	0.124
65	0.335	0.208

	Retired Members and Beneficiaries[1]		Disabled Members (After Year 3)[1]	
Age	Male	Female	Male	Female
50	0.235%	0.131%	1.807%	1.021%
55	0.346	0.206	2.102	1.277
60	0.464	0.274	2.383	1.507
65	0.659	0.413	2.774	1.800
70	1.056	0.681	3.440	2.337
75	1.894	1.252	4.536	3.326
80	3.475	2.401	6.279	4.926
85	6.682	4.788	9.122	7.319
90	12.893	9.746	13.840	10.820
95	22.038	18.269	20.697	16.019

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. The mortality assumption uses a generational mortality approach with a base year of 2019 for the retired tables. Projected improvement is based on 110% of the MP-2019 Ultimate Projection Scale. The rates shown reflect mortality improvement through June 30, 2019. The projection scale does not apply to the select minimum rates.

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Table A-1.3a
Service Retirement – 2% at 60 Males

DB Program - 2% at 60 Members - Males								
	Years of Credited Service							
Age	5-9 years	10-14 years	15-19 years	20-24 years	25 years	26-29 years	30 years	31 or More Years
50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.0%	4.5%
51	0.0	0.0	0.0	0.0	0.0	0.0	3.5	2.5
52	0.0	0.0	0.0	0.0	0.0	0.0	3.5	2.5
53	0.0	0.0	0.0	0.0	0.0	0.0	3.5	2.5
54	0.0	0.0	0.0	0.0	0.0	0.0	3.5	2.5
55	2.0	2.5	3.0	4.0	6.0	5.0	7.5	5.5
56	1.5	1.5	2.0	2.5	4.0	3.5	7.5	5.5
57	1.5	1.5	2.0	2.5	4.0	3.5	10.0	7.5
58	2.0	2.0	2.5	3.5	6.0	5.0	12.5	9.0
59	3.0	3.0	4.0	5.0	8.5	7.0	18.5	13.5
60	4.0	5.0	6.5	8.0	11.5	9.5	28.0	20.5
61	5.0	5.5	7.5	9.0	16.0	13.5	50.0	50.0
62	7.0	8.0	10.5	13.0	25.5	21.0	45.0	45.0
63	8.5	9.5	12.5	15.5	34.5	29.0	35.0	35.0
64	9.0	10.5	13.5	17.0	27.5	23.0	30.0	30.0
65	11.0	13.0	17.0	21.0	32.0	27.0	32.5	32.5
66	11.0	13.0	17.0	21.0	27.5	23.0	30.0	30.0
67	11.0	13.0	17.0	21.0	27.5	23.0	27.0	27.0
68	10.0	11.0	14.5	18.0	27.5	23.0	27.0	27.0
69	10.0	11.0	14.5	18.0	27.5	23.0	25.0	25.0
70	10.0	11.0	14.5	18.0	27.5	23.0	25.0	25.0
71	9.0	10.0	13.0	16.5	27.5	23.0	25.0	25.0
72	9.0	10.0	13.0	16.5	27.5	23.0	25.0	25.0
73	9.0	10.0	13.0	16.5	27.5	23.0	25.0	25.0
74	9.0	10.0	13.0	16.5	27.5	23.0	25.0	25.0
75+	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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

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Table A-1.3b
Service Retirement – 2% at 60 Females

DB Program - 2% at 60 Members - Females								
	Years of Credited Service							
Age	5-9 years	10-14 years	15-19 years	20-24 years	25 years	26-29 years	30 years	31 or More Years
50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.0%	4.5%
51	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.0
52	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.0
53	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.0
54	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.0
55	2.0	3.0	3.5	4.5	6.0	5.0	8.5	6.5
56	1.5	2.0	2.5	3.5	5.0	4.0	8.5	6.5
57	1.5	2.0	2.5	3.5	6.0	5.0	9.5	7.5
58	2.0	3.0	3.5	4.5	7.0	5.5	14.5	11.0
59	3.0	4.0	5.5	7.0	10.0	8.0	18.0	14.0
60	4.0	5.5	7.5	9.5	15.5	12.5	30.5	23.0
61	5.0	7.0	9.5	12.0	21.5	17.0	50.0	50.0
62	7.0	10.0	13.0	17.0	33.0	26.0	48.0	48.0
63	9.0	13.0	17.0	21.5	42.0	33.5	38.0	38.0
64	7.5	11.0	14.5	19.0	36.0	28.5	36.0	36.0
65	10.0	14.5	19.0	24.5	39.0	31.0	38.0	38.0
66	10.0	14.5	19.0	24.5	36.0	28.5	32.0	32.0
67	9.0	13.0	17.0	21.5	36.0	28.5	32.0	32.0
68	9.0	13.0	17.0	21.5	36.0	28.5	30.0	30.0
69	9.0	13.0	17.0	21.5	36.0	28.5	30.0	30.0
70	9.0	13.0	17.0	21.5	36.0	28.5	30.0	30.0
71	8.5	12.0	16.0	20.5	36.0	28.5	30.0	30.0
72	8.5	12.0	16.0	20.5	36.0	28.5	30.0	30.0
73	8.5	12.0	16.0	20.5	36.0	28.5	30.0	30.0
74	8.5	12.0	16.0	20.5	36.0	28.5	30.0	30.0
75+	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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

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Table A-1.3c
Service Retirement – 2% at 62 Males

DB Program - 2% at 62 Members - Males						
	Years of Credited Service					
Age	5-9 years	10-14 years	15-19 years	20-24 years	25-29 years	30 or More Years
50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
51	0.0	0.0	0.0	0.0	0.0	0.0
52	0.0	0.0	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	0.0	0.0	0.0
54	0.0	0.0	0.0	0.0	0.0	0.0
55	1.5	2.0	2.5	3.0	4.0	5.0
56	1.0	1.0	1.5	2.0	2.5	3.0
57	1.0	1.0	1.5	2.0	2.5	3.0
58	1.5	1.5	2.0	2.5	4.0	5.0
59	2.5	2.5	3.0	4.0	5.5	6.5
60	3.0	4.0	5.0	6.0	7.5	9.0
61	4.0	4.0	5.5	7.0	10.5	12.5
62	5.5	6.0	8.0	10.0	16.5	20.0
63	6.5	7.0	9.0	11.5	17.5	21.0
64	7.0	8.0	10.0	13.0	18.0	21.5
65	11.0	13.0	17.0	21.0	28.0	28.0
66	11.0	13.0	17.0	21.0	24.0	24.0
67	13.0	15.5	20.5	25.0	28.5	28.5
68	10.0	11.0	14.5	18.0	24.0	24.0
69	10.0	11.0	14.5	18.0	24.0	24.0
70	10.0	11.0	14.5	18.0	24.0	24.0
71	9.0	10.0	13.0	16.5	24.0	24.0
72	9.0	10.0	13.0	16.5	24.0	24.0
73	9.0	10.0	13.0	16.5	24.0	24.0
74	9.0	10.0	13.0	16.5	24.0	24.0
75	100.0	100.0	100.0	100.0	100.0	100.0

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

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Table A-1.3d
Service Retirement – 2% at 62 Females

DB Program - 2% at 62 Members - Females						
	Years of Credited Service					
Age	5-9 years	10-14 years	15-19 years	20-24 years	25-29 years	30 or More Years
50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
51	0.0	0.0	0.0	0.0	0.0	0.0
52	0.0	0.0	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	0.0	0.0	0.0
54	0.0	0.0	0.0	0.0	0.0	0.0
55	1.5	2.5	2.5	3.5	4.0	5.0
56	1.0	1.5	2.0	2.5	3.0	3.5
57	1.0	1.5	2.0	2.5	4.0	5.0
58	1.5	2.5	2.5	3.5	4.5	5.5
59	2.5	3.0	4.0	5.5	6.5	8.0
60	3.0	4.0	5.5	7.0	10.0	12.0
61	4.0	5.5	7.0	9.0	13.5	16.0
62	5.5	7.5	10.0	13.0	20.5	24.5
63	5.5	8.0	10.5	14.0	21.5	26.0
64	5.5	8.5	11.0	14.5	22.5	27.0
65	10.0	14.5	19.0	24.5	32.5	32.5
66	10.0	14.5	19.0	24.5	30.0	30.0
67	11.0	15.5	20.5	26.0	36.0	36.0
68	9.0	13.0	17.0	21.5	30.0	30.0
69	9.0	13.0	17.0	21.5	30.0	30.0
70	9.0	13.0	17.0	21.5	30.0	30.0
71	8.5	12.0	16.0	20.5	30.0	30.0
72	8.5	12.0	16.0	20.5	30.0	30.0
73	8.5	12.0	16.0	20.5	30.0	30.0
74	8.5	12.0	16.0	20.5	30.0	30.0
75	100.0	100.0	100.0	100.0	100.0	100.0

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

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Table A-1.3e
Service Retirement – 1990 Benefit Structure Males

DB Program - 1990 Structure - Males						
	Years of Credited Service					
Age	5-9 years	10-14 years	15-19 years	20-24 years	25-29 years	30 or More Years
50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
51	0.0	0.0	0.0	0.0	0.0	0.0
52	0.0	0.0	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	0.0	0.0	0.0
54	1.0	1.0	1.5	1.5	1.5	1.5
55	3.5	4.5	5.0	6.0	6.0	6.5
56	2.5	3.0	3.5	4.0	4.0	4.5
57	3.0	4.0	4.5	5.0	5.0	5.5
58	4.0	5.5	6.0	7.0	7.0	8.0
59	10.5	14.0	16.0	17.5	18.5	20.0
60	15.0	20.0	22.5	25.0	26.5	29.0
61	10.0	13.0	15.0	16.5	17.5	19.0
62	10.0	13.0	15.0	16.5	17.5	19.0
63	9.0	12.0	13.5	15.0	16.0	17.5
64	10.5	14.0	16.0	17.5	18.5	20.0
65	12.0	16.0	18.0	20.0	21.0	23.0
66	9.5	13.0	14.5	16.0	17.0	18.5
67	9.5	13.0	14.5	16.0	17.0	18.5
68	9.5	13.0	14.5	16.0	17.0	18.5
69	9.5	13.0	14.5	16.0	17.0	18.5
70+	100.0	100.0	100.0	100.0	100.0	100.0

The assumptions shown above are for retirement from active status. It is assumed that all vested terminated members retire at age 60 under the 1990 Benefit Structure.

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Table A-1.3f
Service Retirement – 1990 Benefit Structure Females

DB Program - 1990 Structure - Females						
	Years of Credited Service					
Age	5-9 years	10-14 years	15-19 years	20-24 years	25-29 years	30 or More Years
50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
51	0.0	0.0	0.0	0.0	0.0	0.0
52	0.0	0.0	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	0.0	0.0	0.0
54	1.0	1.0	1.5	1.5	1.5	1.5
55	4.0	5.5	6.5	7.0	7.5	8.0
56	2.5	3.5	4.0	4.5	4.5	5.0
57	2.5	3.5	4.0	4.5	4.5	5.0
58	4.0	5.5	6.5	7.0	7.5	8.0
59	8.5	11.0	12.5	14.0	14.5	16.0
60	13.0	17.5	20.0	22.0	23.0	25.5
61	9.0	12.0	13.5	15.0	16.0	17.5
62	9.0	12.0	13.5	15.0	16.0	17.5
63	9.0	12.0	13.5	15.0	16.0	17.5
64	11.0	14.5	16.0	18.0	19.0	20.5
65	11.0	14.5	16.0	18.0	19.0	20.5
66	11.0	14.5	16.0	18.0	19.0	20.5
67	11.0	14.5	16.0	18.0	19.0	20.5
68	9.5	13.0	14.5	16.0	17.0	18.5
69	9.5	13.0	14.5	16.0	17.0	18.5
70+	100.0	100.0	100.0	100.0	100.0	100.0

The assumptions shown above are for retirement from active status. It is assumed that all vested terminated members retire at age 60 under the 1990 Benefit Structure.

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Table A-1.4
Disability Retirement

Coverage A		
Age	**Male**	**Female**
25	0.015%	0.015%
30	0.025	0.025
35	0.040	0.050
40	0.065	0.075
45	0.090	0.090
50	0.130	0.180
55	0.170	0.225

Coverage B		
Age	**Male**	**Female**
25	0.010%	0.015%
30	0.015	0.015
35	0.025	0.030
40	0.050	0.055
45	0.085	0.095
50	0.125	0.165
55	0.235	0.285
60	0.345	0.360
65	0.380	0.380
70	0.380	0.380

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Table A-1.5
Other Terminations of Employment (Withdrawal)

Year[1]	Male	Female
0	12.25%	11.25%
1	8.50	7.00
2	6.75	5.50
3	5.40	4.25
4	3.75	3.25
5	3.10	2.70
10	1.65	1.50
15	1.05	1.05
20	0.75	0.75
25	0.50	0.50
30	0.45	0.40

1. Based on elapsed service since membership date.

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Table A-1.6
Probability of Refund

	Entry Ages					
Year[1]	Under 25	25-29	30-34	35-39	40-44	45 and Up
Under 5	100%	100%	100%	100%	100%	100%
5	60	60	60	54	50	45
10	38	38	38	34	25	
15	30	30	28	17		
20	24	22	18			
25	14	12				
30	5					

1. Assumption applied at time of assumed termination based on credited service. Members who terminate with less than five years of credited service are assumed to have 100% probability of refund.

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Table A-1.7
Merit Salary Increases[1]

	Entry Age - Annual Increase in Salaries Due to Merit					
Year[2]	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. The total expected increase in salary includes both merit (shown above) and the general wage increase assumption of 3.50% per annum. The total result is compounded rather than additive. For example, the total assumed increase for service less than one year (Year 0 above) is 10.124% (1.064 x 1.035) for member in the entry age under 25 group.
2. Based on elapsed service since membership date.

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Table A-1.8
Supplemental Assumptions

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 1.7%.

Optional Forms

Active and Inactive: Based on single life annuity assumed.

Retirees and Beneficiaries: Based on optional form in data.

Probability of Eligible Survivor

Male: 85%

Female: 65%

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

Number of Children

Married members under age 60 are assumed to have the number of children shown in the following table. Children are assumed to receive benefits until the member would have turned age 60.

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

Assumed Offsets

No offsets to disability and survivor benefits are assumed.

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 4.3% 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. Non-vested members who have been inactive for less than two years are assumed to take an immediate refund of their member contributions.

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Appendix A-2 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 the 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 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. The Fair Market Value excludes the liability for "Net Pension and OPEB Obligation," which are pre-recognized administrative expenses, from the Fiduciary Net Position reported for accounting purposes.

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-2.1** and illustrated at selected ages in **Table A-2.2**.

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

Economic Assumptions	
Investment Return (net of investment and administrative expenses)	7.00%
Interest on Member Accounts	7.00%
Wage Growth	3.50%
Inflation	2.75%
Standard Deviation of Portfolio	13.10%

Demographic Assumptions		
Mortality[1]		
Retired & Beneficiary - Male	2019 CalSTRS Service Retired Male[2]	Table A-3.2
Retired & Beneficiary - Female	2019 CalSTRS Service Retired Female[2]	Table A-3.2
Disabled - Male	2019 CalSTRS Disabled Retiree Male[2]	Table A-3.2
Disabled - Female	2019 CalSTRS Disabled Retiree Female[2] (select rates in first three years for both Males and Females)	Table A-3.2

1. The mortality assumption uses a generational mortality approach with a base year of 2019. Projected improvement is based on 110% of the MP-2019 Ultimate Projection Scale. The combined base tables and projection scale specified contain a margin for expected future mortality improvement.

2. The 2019 retired, disabled and beneficiary mortality tables have not changed from the prior tables, except they have been projected forward to 2019 with mortality improvement.

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

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Table A-2.2
Mortality

	Retired Members and Beneficiaries[1]		Disabled Members (After Year 3)[1]	
Age	Male	Female	Male	Female
50	0.235%	0.131%	1.807%	1.021%
55	0.346	0.206	2.102	1.277
60	0.464	0.274	2.383	1.507
65	0.659	0.413	2.774	1.800
70	1.056	0.681	3.440	2.337
75	1.894	1.252	4.536	3.326
80	3.475	2.401	6.279	4.926
85	6.682	4.788	9.122	7.319
90	12.893	9.746	13.840	10.820
95	22.038	18.269	20.697	16.019

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. The mortality assumption uses a generational mortality approach with a base year of 2019. Projected improvement is based on 110% of the MP-2019 Ultimate Projection Scale. The rates shown reflect mortality improvement through June 30, 2019. The projection scale does not apply to the select minimum rates.

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.

Appendix A-3 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 the 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 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. The Fair Market Value excludes the liability for "Net Pension and OPEB Obligation," which are pre-recognized administrative expenses, from the Fiduciary Net Position reported for accounting purposes.

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

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

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

Economic Assumptions	
Investment Return (net of investment and administrative expenses)	6.50%
Interest on Member Accounts	6.50%
Wage Growth	3.50%
Inflation	2.75%
Standard Deviation of Portfolio	11.00%

Demographic Assumptions		
Mortality[1]		
Retired & Beneficiary - Male	2019 CalSTRS Service Retired Male[2]	Table A-3.2
Retired & Beneficiary - Female	2019 CalSTRS Service Retired Female[2]	Table A-3.2
Disabled - Male	2019 CalSTRS Disabled Retiree Male[2]	Table A-3.2
Disabled - Female	2019 CalSTRS Disabled Retiree Female[2] (select rates in first three years for both Males and Females)	Table A-3.2

1. The mortality assumption uses a generational mortality approach with a base year of 2019. Projected improvement is based on 110% of the MP-2019 Ultimate Projection Scale. The combined base tables and projection scale specified contain a margin for expected future mortality improvement.

2. The 2019 retired, disabled and beneficiary mortality tables have not changed from the prior tables, except they have been projected forward to 2019 with mortality improvement.

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

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

Table A-3.2
Mortality

	Retired Members and Beneficiaries[1]		Disabled Members (After Year 3)[1]	
Age	Male	Female	Male	Female
50	0.235%	0.131%	1.807%	1.021%
55	0.346	0.206	2.102	1.277
60	0.464	0.274	2.383	1.507
65	0.659	0.413	2.774	1.800
70	1.056	0.681	3.440	2.337
75	1.894	1.252	4.536	3.326
80	3.475	2.401	6.279	4.926
85	6.682	4.788	9.122	7.319
90	12.893	9.746	13.840	10.820
95	22.038	18.269	20.697	16.019

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. The mortality assumption uses a generational mortality approach with a base year of 2019. Projected improvement is based on 110% of the MP-2019 Ultimate Projection Scale. The rates shown reflect mortality improvement through June 30, 2019. The projection scale does not apply to the select minimum rates.

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.

Appendix A-4: Medicare Premium Payment Program Actuarial Methods and Assumptions

This section of the report discloses the actuarial methods and assumptions used in the Actuarial Valuation of the MPP Program. These methods and assumptions havg65

e been chosen on the basis of recent experience of the MPP Program and on current expectations as to future economic conditions.

The assumptions are intended to estimate the future experience of the members of the MPP Program and of the MPP 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 MPP Program's benefits.

Actuarial Cost Method

The cost method used for the MPP Program valuation is the Entry Age Normal Cost Method. Since there are no active members eligible to receive future MPP Program benefits, the Normal Cost is $0, and 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. The assets in the THBF are valued at Fair Market Value but exclude line items for "Net Pension and OPEB Obligation" for funding purposes.

Asset Valuation Method

For funding purposes, the assets are valued as the allocated value of DB Program Assets. This figure is equal to the actuarial obligation of the MPP Program benefits.

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 demographic assumptions are listed in **Table A-1.1.**

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

Table A-4.1
Recommended June 30, 2019 Valuation Assumptions

	June 30, 2019 Valuation (Recommended)	*June 30, 2018 Valuation*
Retirement/Termination/Disability/Mortality	Same as DB Program valuation	Same as DB Program valuation
Enrollment Rates	Lower rates recommended (See Exhibits 11-2 & 11-3)	See Table A-4.2
Interest Rate		
- For funding	7.00%, same as DB Program Valuation	7.00%, same as DB Program Valuation
- For GASB reporting (for following year)	3.50% (Based on Bond Buyer 20-Bond GO Index)	3.87% (Based on Bond Buyer 20-Bond GO Index)
Part A Premiums		
- Initial premium	$458 (CY 2020)	$437 (CY 2019)
- Inflation (trend)	Varies by year equivalent to fixed 4.5%	Varies by year equivalent to fixed 3.7%
Part B Premiums		
- Initial premium[1]	$144.60 (CY 2020)	$135.50 (CY 2019)
- Inflation (trend)	Varies by year equivalent to fixed 5.4%	Varies by year equivalent to fixed 4.1%

1. CalSTRS pays the Part B penalty, which is a percentage of the Part B premium amount.

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Table A-4.2
Summary of Part A[1] Enrollment Rates – Best Estimate (Valuation Assumptions)

Assumption	Recommended June 30, 2019	Current Assumptions June 30, 2018
% of under 65 retirees enrolling (retired on or after 2001) [2]	2.00%	2.50%
% of under 65 retirees enrolling (retired before 2001)	2.00%	3.50%
% of over 65 retirees enrolling (for those not currently enrolled) at age:[3]		
65	0.20%	0.60%
66	0.02	0.06
67	0.02	0.04
68	0.02	0.03
69	0.02	0.03
70-84	0.02	0.02
85 & above	0.00	0.00
% of over 65 retirees enrolling (for those already enrolled)	100.0%	100.0%

1. Only current enrollees are assumed to receive Part B payments.

2. For under age 65 retirees, the enrollment percent applies upon reaching age 65. No enrollment is assumed after age 65 for retirees currently under age 65.

3. For over 65 retirees, the enrollment percent applies in each future year.

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Table A-4.3
Summary of Part A[1] Enrollment Rates – Higher Cost

Assumption	Recommended June 30, 2019	Current Assumptions June 30, 2018
% of under 65 retirees enrolling (retired on or after 2001) [2]	2.50%	3.00%
% of under 65 retirees enrolling (retired before 2001)	2.50%	4.25%
% of over 65 retirees enrolling (for those not currently enrolled) at age:[3]		
65	0.40%	0.80%
66	0.04	0.10
67	0.04	0.08
68	0.04	0.06
69	0.04	0.04
70-84	0.03	0.03
85 & above	0.00	0.00
% of over 65 retirees enrolling (for those already enrolled)	100.0%	100.0%

1. Only current enrollees are assumed to receive Part B payments.

2. For under age 65 retirees, the enrollment percent applies upon reaching age 65. No enrollment is assumed after age 65 for retirees currently under age 65.

3. For over 65 retirees, the enrollment percent applies in each future year.

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