Fire and Police Pension Association of Colorado

2018 Actuarial Experience Study
for the Period Ending December 31, 2017

GRS Retirement Consulting

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September 21, 2018

Board of Directors
Fire and Police Pension Association of Colorado
5290 DTC Parkway, #100
Greenwood Village, Colorado 80111

Subject: Results of the 2018 Experience Study

Dear Members of the Board:

We are pleased to present our report of the results of the 2018 Actuarial Experience Investigation Study for the Fire and Police Pension Association of Colorado ("FPPA"). Our report includes a discussion of the recent experience of the System, it presents our recommendations for new actuarial assumptions and methods, and it provides information about the actuarial impact of these recommendations on the liabilities and other key actuarial measures of FPPA.

With the Board of Trustees' approval of the recommendations in this report, we believe the actuarial condition of the System will be more accurately measured and portrayed.

This experience investigation study was conducted in accordance with generally accepted actuarial principles and practices, and in full compliance with the Actuarial Standards of Practice as issued by the Actuarial Standards Board. All of the undersigned are members of and meet the Qualification Standards of the American Academy of Actuaries.

We wish to thank the FPPA staff for their assistance in this project.

Respectfully submitted,

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Pension Market Leader

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SECTION A

EXECUTIVE SUMMARY

Executive Summary

Our recommended changes to the key current actuarial assumptions and methods used in the valuations are summarized below. These recommendations are described in detail in Section C.

Economic assumptions

1. Based on a recommended unchanged inflation rate of 2.50%, we recommend reducing the current nominal investment assumption from 7.50% to either 7.25% or 7.00% to reflect reduced real return expectations from a recent capital market survey of several investment consultants.
2. Increase the productivity component of the salary scale assumption from 1.50% to 1.75%. Combined with the inflation rate of 2.50%, this creates an ultimate salary scale assumption of 4.25%. In accordance with the observed experience, slightly lower the service-based promotional/longevity component of the salary scale. The net impact is immaterial to the overall liability calculations.

Demographic assumptions

1. Remove the blue collar adjustment from the mortality tables being used and update the mortality projection scale from Scale BB to the ultimate rates of the MP-2017 projection scale.
2. Increase disability rates for members covered by a defined benefit program.
3. Increase termination rates for participants in the Volunteer Fire Affiliated Plans by 10%. Leave other termination rates unchanged.
4. Slightly modify Statewide Defined Benefit Plan and Statewide Hybrid Plan retirement rates to reflect increased early retirement utilization for low service members and slightly decreased normal retirement rates after age 55. These modified retirement rates are used as building blocks in setting the rates for the Colorado Springs New Hire Plans.

Actuarial methods

1. Limit the amortization period used in the Statewide Defined Benefit Plan used to determine the Actuarially Determined Contribution Rate such that no negative amortization results (the payment always covers at least the interest on the unfunded liability). This only impacts disclosure information when the funded ratio is below 100%.

SECTION B

INTRODUCTION

Introduction

Summary of Process

A periodic review and selection of the actuarial assumptions is one of many important components of understanding and managing the financial aspects of FPPA. Use of outdated or inappropriate assumptions can result in understated costs which will lead to higher future contribution requirements or perhaps an inability to pay benefits when due; or, on the other hand, produce overstated costs which place an unnecessarily large burden on the current generation of members, employers, and taxpayers.

A single set of assumptions is typically not expected to be suitable forever. As the actual experience unfolds or the future expectations change, the assumptions should be reviewed and adjusted accordingly.

It is important to recognize that the impact from various outcomes and the ability to adjust from experience deviating from the assumption are not symmetric. Due to compounding economic forces, legal limitations, and moral obligations outcomes from underestimating future liabilities are much more difficult to manage than outcomes of overestimates, and that asymmetric risk should be considered when the assumption set, investment policy and funding policy are created. As such, the assumption set used in the valuation process needs to represent the best estimate of the future experience of the System and be at least as likely, if not more than likely, to overestimate the future liabilities versus underestimate them.

Using this strategic mindset, each assumption was analyzed compared to the actual experience of FPPA and general experience of other large public employee retirement systems. Changes in certain assumptions and methods are suggested upon this comparison to remove any bias that may exist and to perhaps add in a slight margin for future adverse experience where appropriate. Next, the assumption set as a whole was analyzed for consistency and to ensure that the projection of liabilities was reasonable and consistent with historical trends.

The following report provides our recommended changes to the current actuarial assumptions.

In determining liabilities, contribution rates and funding periods for retirement plans, actuaries must make assumptions about the future. Among the assumptions that must be made are:

- Retirement rates
- Mortality rates
- Turnover rates
- Disability rates
- Investment return rate
- Salary increase rates
- Inflation rate

For some of these assumptions, such as the turnover or retirement rates, past experience provides important evidence about the future. For other assumptions, such as the investment return rate, the link between past and future results is much weaker. In either case, though, actuaries should review their assumptions periodically and determine whether these assumptions are consistent with actual past experience and with future expectations.

In conducting experience studies, actuaries generally use data over a period of several years. This study is generally based on experience during the four-year period of January 1, 2014 to December 31, 2017. The last experience study was prepared in 2015, following completion of the January 1, 2015 actuarial valuation report. That report generally covered experience during the period of January 1, 2011 to December 31, 2014. This is necessary in order to gather enough data so that the results are statistically significant. In addition, if the study period is too short, the impact of the current economic conditions may lead to misleading results. It is known, for example, that the strength of the national and local economy can impact salary increase rates and withdrawal rates. Using results gathered during a short-term boom or bust will not be representative of the long-term economic trends.

Also, the adoption of new legislation that impacts benefits or compensation may cause a short-term distortion in the experience. For example, if an early retirement window were opened during the study period, we would usually see a short-term spike in the number of retirements followed by a dearth of retirements for the following two-to-four years. Using a longer period to observe the plan's experience reduces the influence of such short-term effects. On the other hand, using a much longer period may not immediately reflect real changes that may be occurring, such as mortality improvement or a change in the ages at which members retire. In our view, using a four-to six-year period appropriately balances these effects.

In an experience study, we first determine the number of deaths, retirements, etc. that occurred during the period. Then we determine the number expected to occur, based on the current actuarial assumptions. The number "expected" is determined from using the probability of the occurrence at the given age, times the "exposures" at that same age. For example, let's look at a rate of retirement of 50% at age 55. The number of exposures can only be those members who are age 55 and eligible for retirement at that time. Thus they are considered "exposed" to that assumption. Finally we calculate the A/E ratio, where "A" is the actual number (of retirements, for example) and "E" is the expected number. If the current assumptions precisely predicted the actual experience the A/E ratio would be 100%. When it varies much from this figure, it is a sign that new assumptions may be needed. Of course we not only look at the assumptions as a whole, but we also review how well they fit the actual results by sex, by age, and by service.

Please note it is often appropriate to graduate or smooth the results since the actual experience can be quite uneven from age to age or from service year to service year.

Please bear in mind that, while the recommended assumption set represents our best estimate, there are other reasonable assumptions sets that could be supported. Some reasonable assumption sets would show higher or lower liabilities or costs.

Plans Studied

This study pertains to the following plans:

- Statewide Defined Benefit Plan (SWDB)
- Statewide Death and Disability Plan (SWDD) which includes members covered under the Defined Benefit (DB) Plans as well as the Money Purchase (MP) Plans
- Statewide Hybrid Plan – Defined Benefit Component (SWH)
- Colorado Springs New Hire Plans
- Local defined benefit pension plans for firefighter and police employees in the State of Colorado hired before April 8, 1978 whose employers have chosen to affiliate with FPPA (Old Hire Plans)
- Volunteer firefighter defined benefit pension plans in the State of Colorado who have chosen to affiliate with FPPA (Volunteer Plans)

The study was largely based on census data for the SWDB plan. The study of disability incidence and disabled mortality was completed using census data for the SWDD plan. Census data for the Volunteer Firefighter plans was used to review the termination and retirement assumption for those plans.

Organization of Report

Section C contains our findings and recommendations for each actuarial assumption. The impact of adopting our recommendations on liabilities and contribution rates is shown in Section D. Section E summarizes the recommended changes. Section E presents a summary of all the actuarial assumptions and methods, including the recommended changes.

The exhibits in Section F should generally be self-explanatory. For example, on page 47, we show the exhibit analyzing the termination rates for the Statewide Defined Benefit Plan. The second column shows the total number of members who terminated during the study period. This excludes members who died, became disabled or retired. Column (3), labeled "Total Count" shows the total exposures. This is the number of members who could have terminated during any of the years. On this exhibit, the exposures exclude anyone eligible for retirement. A member is counted in each year he could have terminated, so the total shown is the total exposures for the five-year period. Column (4) shows the probability of termination based on the raw data. That is, it is the result of dividing the actual number of terminations (col. 2) by the number exposed (col. 3). Column (5) shows the current termination rate and column (6) shows the new recommended termination rate. Columns (7) and (8) show the expected numbers of terminations based on the current and proposed termination assumptions. Columns (9) and (10) show the Actual-to-Expected ratios under the current and proposed termination assumptions.

SECTION C

ANALYSIS OF EXPERIENCE AND RECOMMENDATIONS

Analysis of Experience and Recommendations

We will begin by discussing the economic assumptions: inflation, the investment return rate, the salary increase assumption, the cost-of-living increases (COLAs), and the payroll growth rate. Next, we will discuss the demographic assumptions: mortality, disability, termination and retirement. Finally, we will discuss the actuarial methods used to calculate the liability, funded status, and contribution rate.

Actuarial Standards of Practice for Setting Economic Assumptions

Actuarial Standards of Practice (ASOP) No. 27, Selection of Economic Assumptions for Measuring Pension Obligations, provides guidance to actuaries on giving advice on selecting economic assumptions for measuring obligations for defined benefit pension plans. ASOP No. 27 was revised and adopted by the Actuarial Standards Board (ASB) in September 2013 and supplements ASOP 4, Measuring Pension Obligations and Determining Plan Costs or Contributions.

As no one knows what the future holds, it is necessary for an actuary to estimate possible future economic outcomes. Recognizing that there is not one right answer, the current standard calls for an actuary to develop a reasonable economic assumption. A reasonable assumption is one that:

1. Is appropriate for the purpose of the measurement,
2. reflects the actuary's professional judgment,
3. takes into account historical and current economic data that is relevant as of the measurement date,
4. is an estimate of future experience; an observation of market data; or a combination thereof, and
5. has no significant bias except when provisions for adverse deviation or plan provisions that are difficult to measure are included.

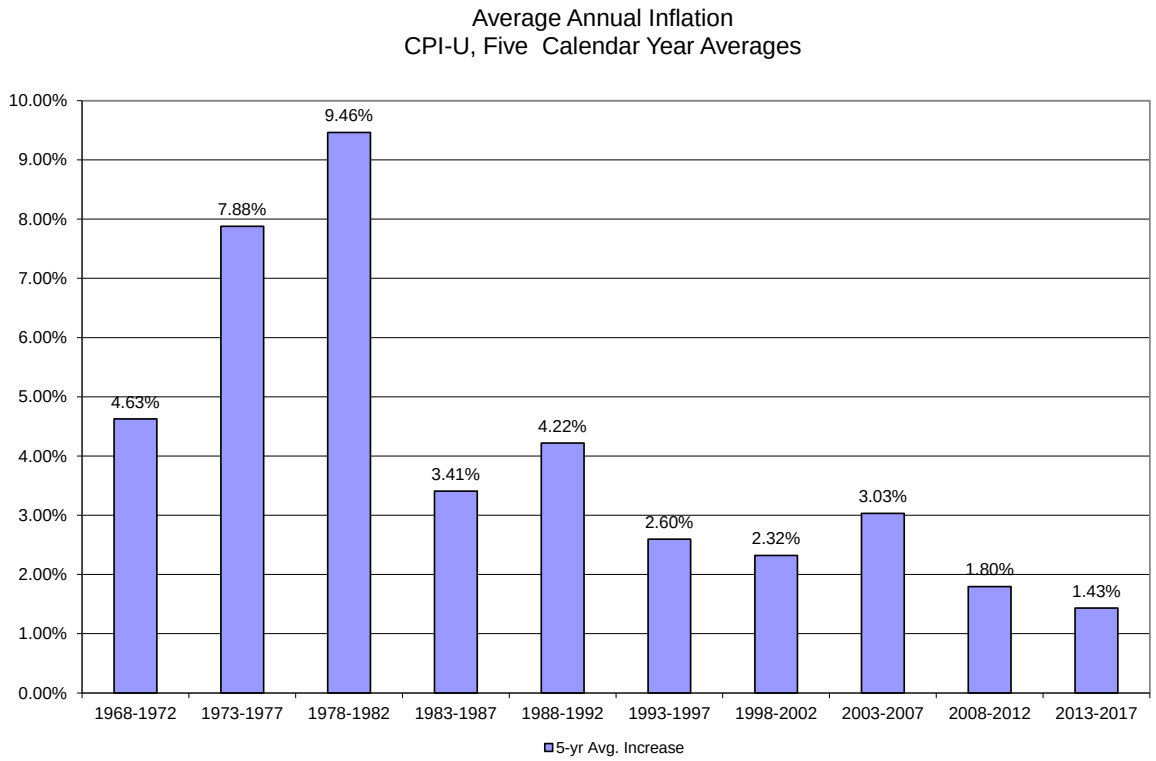
However, the standard explicitly advises an actuary not to give undue weight to recent experience.

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. Generally, the economic assumptions are much more subjective in nature than the demographic assumptions.

Inflation rate

"Inflation," refers to price inflation, as measured by annual increases in the Consumer Price Index (CPI). This inflation assumption underlies all of the other economic assumptions we employ. It impacts investment return, salary increases, and cost-of-living increases (COLAs) in retiree benefits.

The chart on the following page shows the average annual inflation in each of the ten consecutive five-year periods over the last fifty years.



Source: Bureau of Labor Statistics, CPI-U, all items, not seasonally adjusted

The table below shows the average inflation over various periods, ending December 2017:

Periods Ending Dec. 2017	Average Annual Increase in CPI-U
Last five (5) years	1.43%
Last ten (10) years	1.61%
Last fifteen (15) years	2.08%
Last twenty (20) years	2.14%
Last twenty-five (25) years	2.23%
Last thirty (30) years	2.56%
Since 1913 (first available year)	3.13%

Source: Bureau of Labor Statistics, CPI-U, all items, not seasonally adjusted

As you can see, inflation has been relatively low, even over a longer period of 25 years. However, the prospective inflation rate is only weakly tied to past results.

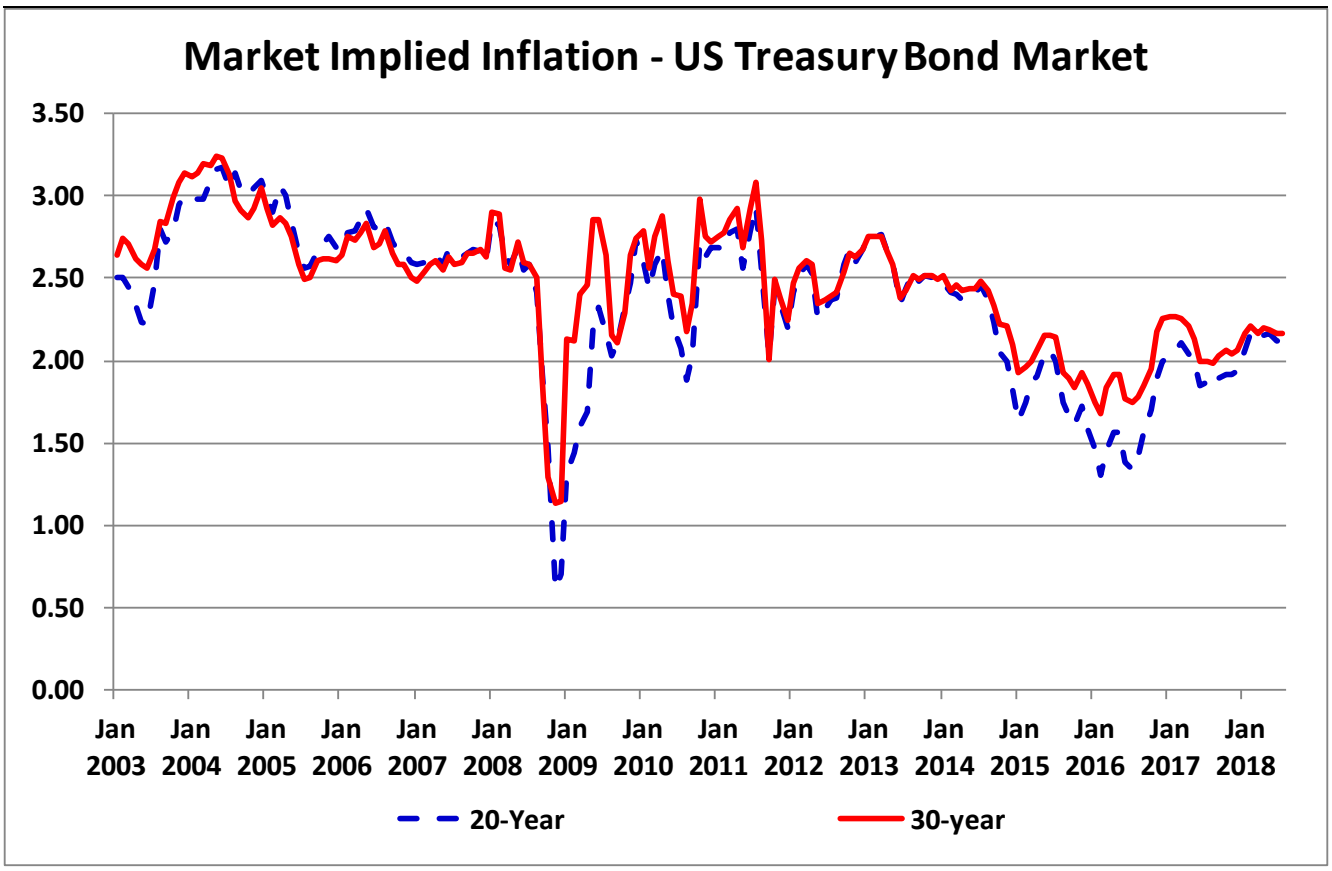
Most investment consulting firms, in setting their capital market assumptions, currently assume that inflation will be less than 2.50%. We examined the 2018 capital market assumption sets for 12 investment consulting firms. The average assumption for inflation was 2.20%, with a range of 1.95% to 2.50%.

Forecasts from Social Security Administration

In the Social Security Administration's 2018 Trustees Report, the Office of the Chief Actuary is projecting a long-term average annual inflation rate of 2.6% under the intermediate cost assumption. The low cost and high cost scenarios are 2.0% and 3.2%, respectively. All three of these numbers are unchanged from the prior year's report.

Expectations Implied in the Bond Market

Another source of information about future inflation is the market for US Treasury bonds. For example, the July 31, 2018 yield for 20-year inflation indexed Treasury bonds was 0.88% plus actual inflation. The yield for 20-year non-indexed US Treasury bonds was 3.03%. Simplistically, this means that on that day the bond market was predicting that inflation over the next twenty years would average 2.15% (3.03% – 0.88%) per year. The difference in yield for 30 year bonds implies 2.14% inflation over the next 30 years. This is consistent with most forecasts of inflation and overall economic growth continuing to be low. The chart below shows the historical market implied inflation from January 2003 through July 2018.



Historically, this has been a consistent predictor of future inflation. However, this analysis is known to be imperfect as it ignores the inflation risk premium that buyers of US Treasury bonds often demand as well as possible differences in liquidity between US Treasury bonds and TIPS.

Survey of Professional Forecasters and Fed Policy

The Philadelphia Federal Reserve conducts a quarterly survey of the Society of Professional Forecasters. Their most recent forecast (second quarter of 2018) was for inflation over the next ten years (2018 to 2027) to average 2.30%.

Additionally, the Fed has openly stated that they have a target 2.00% inflation rate.

Recommendation

As a result, we recommend leaving this assumption unchanged at 2.50%.

Investment and administrative expenses

Since the trust fund pays expenses in addition to member benefits and refunds, we must make some assumption about these. Almost all actuaries treat investment expenses as an offset to the investment return assumption. That is, the investment return assumption represents expected return after payment of investment expenses.

For investment expenses, investment consulting firms periodically issue reports that describe their capital market assumptions. The estimates for core investments (i.e., fixed income, equities, and real estate) are generally based on anticipated returns produced by passive index funds that are net of investment related fees. The investment return expectations for the alternative asset class such as private equity and hedge funds are also net of investment expenses. Therefore, we did not make any adjustments to account for investment related expenses. Some of the Retirement Systems may also employ active management investment strategies that result in higher investment expenses compared to strategies that invest in passive index funds. We have assumed that active management strategies would result in the same returns, net of investment expenses, as passive management strategies.

For FPPA, the practice for administrative expenses has been to explicitly add a load onto the normal cost. This is also our preferred approach and we recommend continuing this practice. Using an explicit load onto the normal cost maximizes transparency, aligns better with the standards of the Governmental Accounting Standards Board, and maintains a parallel between the investment returns used by the investment consultant and the actuary.

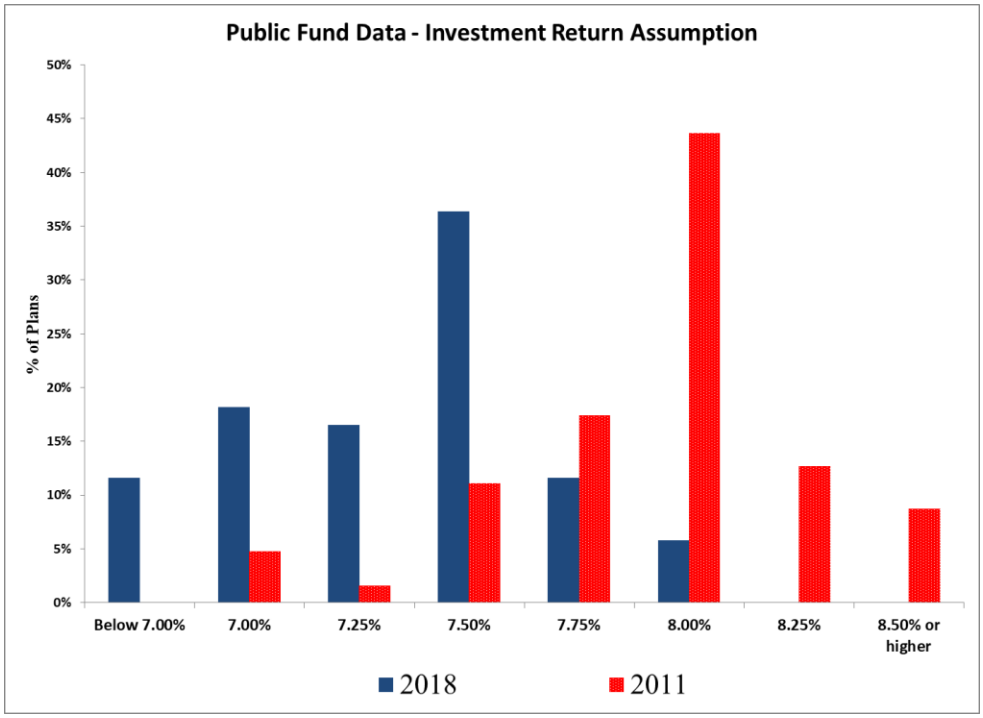
The explicit load is based on actual administrative expenses paid in the prior year. In some cases, this dollar amount is converted to a percentage of payroll based on valuation payroll. For the Volunteer and Old Hire Plans, this amount is based on an average of the actual administrative expenses in the prior two years due to the biennial nature of these plans.

Investment return rate

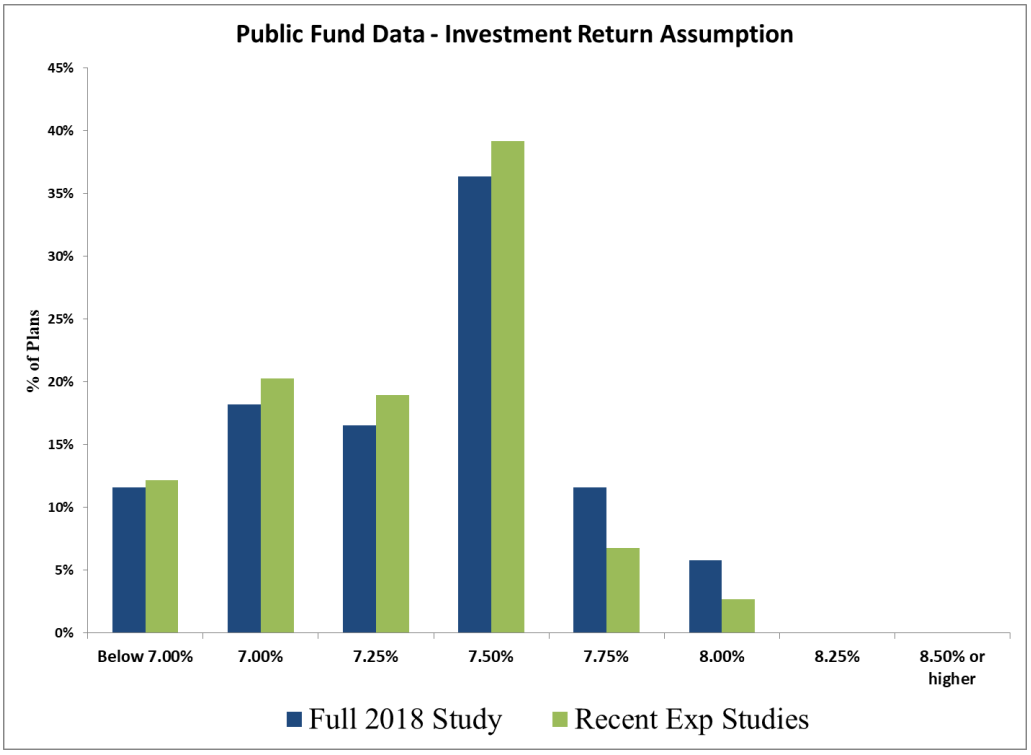
Currently, FPPA assumes an annual investment return rate of 7.50%. This is the rate used in discounting future benefit payments in calculating the actuarial present value of benefits as of the valuation date. Similar to the inflation assumption, past performance is not a reliable indicator of future performance, even when averaged over a long time period. Also, the actual asset allocation of the trust fund will significantly impact the overall performance, so returns achieved under a different allocation are not meaningful.

Assumption Comparison to Peers

We do not recommend the selection of an investment return assumption based on prevalence information. However, it is still informative to identify where the investment return assumption for FPPA is compared to its peers. The chart below shows the distribution of the investment return assumptions in the NASRA Public Fund Data as of July 2018.



We have included the same information from the 2011 survey to show the national trends in this assumption. The median rate of return is 7.46%. However, this chart does not tell the entire story. Several of the data points have not been examined in a few years, meaning even the current survey data is somewhat dated. The following chart includes a subset of the current survey that only includes systems that we can confirm have performed experience studies in the last 2 years:



For recent experience studies, the median assumption has been closer to 7.33%.

Asset Allocation

The actual asset allocation of the trust fund will significantly impact the overall performance, so returns achieved under a different allocation are not meaningful. More importantly, the real rates of return for many asset classes, especially equities, vary so dramatically from year to year that even a ten-year period is not long enough to provide reasonable guidance. We believe a better approach to selecting an investment return assumption is to determine the median expected portfolio return given the fund's targeted allocation and an overall set of capital market assumptions

Per information received from FPPA, the Fund's current target asset allocation is as follows:

Asset Class	Target Allocation
Cash	2.0 %
Fixed Income	15.0 %
Managed Futures	4.0%
Absolute Return	9.0 %
Long Short	9.0 %
Global Public Equity	37.0 %
Private Capital	24.0 %
Total	100.0%

Because GRS is a benefits consulting firm and does not develop or maintain our own capital market assumptions, we utilized the forward-looking return expectations developed by 12 national consulting firms.

These investment consulting firms periodically issue reports that describe their capital market assumptions. That is, their estimates of expected returns, volatility, and correlations. While these assumptions are developed based upon historical analysis, many of these firms also incorporate forward-looking adjustments to better reflect near-term expectations.

Given the plan's current asset allocation and the investment consultants' capital market assumptions, the development of the average expected compound return, net of investment expenses, is provided in the following table.

Expected Annual Geometric Returns and Return Probabilities
(Based on Current Capital Market Assumptions)

Investment Consultant	Distribution of 10-Year Average Geometric Net Nominal Return			Probability of exceeding 7.50%	Probability of exceeding 7.25%	Probability of exceeding 7.00%
	40th	50th	60th			
(1)	(2)	(3)	(4)	(5)	(4)	(3)
1	5.2%	6.2%	7.1%	36.2%	38.7%	41.3%
2	5.1%	6.3%	7.4%	39.4%	41.5%	43.6%
3	5.4%	6.4%	7.4%	38.6%	41.1%	43.6%
4	5.4%	6.5%	7.6%	41.3%	43.5%	45.8%
5	5.6%	6.7%	7.9%	43.1%	45.4%	47.6%
6	5.8%	6.8%	7.7%	41.9%	44.6%	47.3%
7	5.4%	6.8%	8.2%	44.9%	46.6%	48.4%
8	5.8%	6.8%	7.8%	42.7%	45.2%	47.7%
9	5.6%	6.9%	8.3%	45.6%	47.5%	49.4%
10	5.9%	7.0%	8.1%	45.3%	47.7%	50.0%
11	6.6%	7.7%	8.9%	52.1%	54.3%	56.4%
12	7.8%	8.6%	9.4%	63.9%	66.9%	69.9%
Average	**5.81%**	**6.89%**	**7.97%**	**44.6%**	**46.9%**	**49.3%**

As shown, based on this survey, the average expected median return for the next 10 years is 6.89%. We do have three sources of longer term expectations (20-30 years) , and they are 0.25%-0.50% higher. However, we do believe these lower expectations over the shorter time frame should be at a minimum partially reflected in the assumption.

Thus, based on this analysis, we recommend that FPPA lower their investment return assumption used for valuing the Statewide Defined Benefit Plan to either 7.25% or 7.00% (or a point in-between). The other plans (SWH-DB, SWDD, Volunteer) under the FPPA umbrella have shorter time horizons than the SWDB plan (the duration of their liabilities is shorter) and thus stronger consideration should be given to the 7.00% recommendation for those. In our opinion, the process above meets all of the requirements needed to use that as a basis for our analysis. The results were appropriate for the purpose of the measurement, as the estimates were medium to longer term forecasts of market expectations. They took into account historical and current economic data that is relevant as of the measurement date, represent an estimate of future experience and an observation of market data, and had no significant bias (i.e., it is not significantly optimistic or pessimistic).

Asset Allocation Considerations

The real return analysis and nominal investment return recommendations are highly dependent on the asset allocation targets currently in place for the assets under FPPA management. Currently the FPPA Staff and Board are considering whether a single asset allocation continues to be the best approach for the plans under their management. In particular, the Old Hire Plans are closed and do not have the same time horizon when compared with the other plans. A separate study is currently ongoing regarding the asset allocation for these plans, and a separate investment return analysis will be performed when an asset allocation recommendation is in place for these plans. Regardless of the asset allocation recommended, it is highly unlikely that the 7.25% or 7.00% recommendation will be supportable for these plans due to the short time horizon of the plan liabilities. We will revisit our recommendations with the Board once final decisions are made for the policies going forward.

Salary increase rates

In order to project future benefits, the actuary must project future salary increases for individuals. Salaries may increase for a variety of reasons:

- Across-the-board increases for all employees;
- Across-the-board increases for a given group of employees;
- Increases to a minimum salary schedule;
- Additional pay for additional duties;
- Step or service-related increases;
- Increases for acquisition of advanced degrees or specialized training;
- Promotions; or
- Merit increases, if available.

Our salary increase assumption is meant to reflect all of these types of increases.

Salary increases for governmental employees can vary significantly from year to year. When the employer's tax revenues stall or increase slowly, salary increases often are small or nonexistent. During good times, salary increases can be larger. Our experience across many governmental plans also shows several occasions in which salary increases will be low for a period of several years followed by a significant increase in one year. Therefore, for this assumption in particular, we prefer to use data over a longer period in establishing our assumptions. We used a ten-year period for this analysis (but also looked back at older studies).

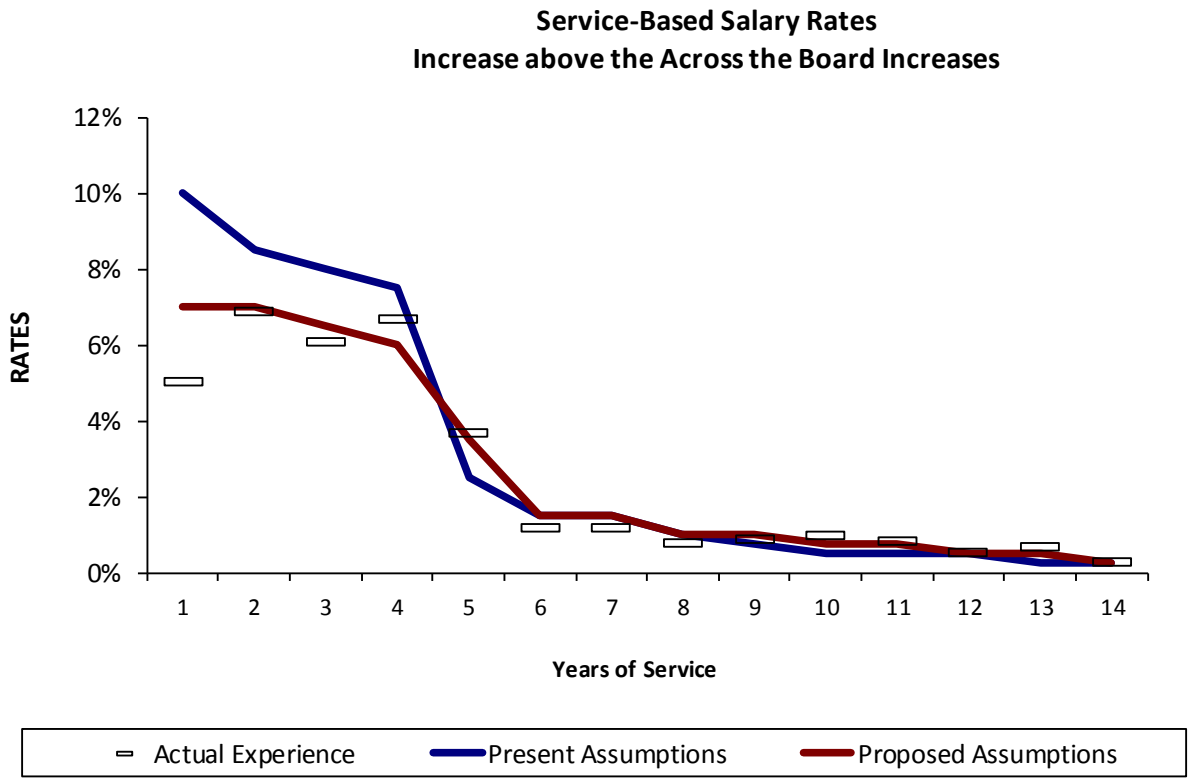
Most actuaries recommend salary increase assumptions that include an element that depends on the member's age or service, especially for large, public retirement systems. It is typical to assume larger pay increases for younger or shorter-service employees. This is done in order to reflect pay increases that accompany step increases, changes in job responsibility, promotions, demonstrated merit, etc. The experience shows salaries have been more closely correlated to service (rather than age), as promotions and productivity increases tend to be greater in the first few years of a career, even if the new employee is older than the average new hire.

The current salary increase assumption is a service related table that begins with 14.00% annual increases for new members decreasing to 4.00% annual increases for members with 15 or more years of service.

To separate the steps, or promotional component of the schedule, we segregated out members with more than 14 years of service. Most of these members should be past the promotional and step portions of their careers and, therefore, only receive the general increases granted and a small amount of individual merit.

Period	Overall Increase for Long Service Members	Inflation	Increase Above Inflation
Calendar Year 2008	5.69%	0.09%	5.60%
Calendar Year 2009	4.90%	2.72%	2.18%
Calendar Year 2010	1.51%	1.50%	0.01%
Calendar Year 2011	6.40%	2.96%	3.44%
Calendar Year 2012	3.86%	1.74%	2.11%
Calendar Year 2013	2.58%	1.50%	1.08%
Calendar Year 2014	1.70%	0.76%	0.94%
Calendar Year 2015	3.51%	0.73%	2.78%
Calendar Year 2016	5.35%	2.08%	3.27%
Calendar Year 2017	3.29%	2.13%	1.16%
Average	**3.88%**	**1.62%**	**2.26%**

The average actual increase of 3.88% was close to the expected 4.00% increase, so the nominal increases have been about as expected. However, the actual inflation experience has been significantly lower than assumed which implies a greater productivity component. The actual general productivity increase during the ten year period was 2.26%, which is in excess of national averages. We believe increasing the productivity component from 1.50% to 1.75% is a reasonable assumption for pay increases going forward. Combined with the unchanged inflation assumption of 2.50%, we recommend a nominal ultimate pay increase assumption of 4.25% (2.50% inflation plus 1.75% productivity and merit).



The above exhibit models the portion of the salary increases for short term members that exceeded the salary increases for long term members based on the current assumptions, the actual experience, and a set of new proposed assumptions if applicable. Based on the observed experience, the service-based increases assumed at short tenures were reduced early in the member's career.

This change in aggregate (lowering the step portion of the salary scale but increasing the across the board portion) is consistant with other trends we have observed in the data for our other clients where more of the pay increase budget is going to general increases and the step rates are becoming flatter.

Payroll growth rate

The salary increase rates discussed above are assumptions applied to individuals. They are used in projecting future benefits. For purposes of determining certain results as a level percentage of pay, we also use a separate payroll growth assumption, which is currently 3.50% per year. This number is used in determining the contribution needed to amortize the unfunded actuarial accrued liability as a level percentage of pay (primarily in the SWDB plan) and in determining the new entrant pay in the funding projections. Since the SWDB plan currently has no unfunded actuarial accrued liability, this assumption is only used for indexing the new entrant pay and has little impact on the valuation results.

Payroll often grows at a rate different from the average pay increases for individual members. Reasons include when older, longer-service members leave employment they are generally replaced with new members who are starting with a lower salary. Because of this, in most populations that are not growing in size, the growth in total payroll will be smaller than the average pay increase for members. On the other hand, payroll can grow due to an increase in the size of the group.

After adjusting for counts, payroll in the Statewide Defined Benefit Plan has grown on average 2.42% over the last ten years, during a time when inflation was 1.62%. Thus, payroll has grown on average 0.80% above inflation.

We believe a reasonable range for this assumption is between the 2.50% inflation assumption and the 4.25% ultimate merit and productivity portion of the individual salary scales. In addition, the payroll growth above inflation of 0.80% suggests that a payroll growth of roughly 3.30% may also be appropriate. We are recommending no change to the current nominal value of 3.50% for this assumption.

Cost-of-living (COLAs) increase assumption

Cost-of-living increases are at the discretion of the FPPA Board for the three statewide plans (SWDB, SWH-DB, SWDD). As such, no cost-of-living adjustment is assumed for the baseline valuation results.

For the Colorado Springs New Hire Plans, increases are automatic and tied to inflation. As no change was recommended to the inflation assumption, no change is recommended to the cost-of-living adjustment assumption used for these two plans.

Some Old Hire Plans include a rank escalation increase in benefits (as active members receive an increase in pay, retirees receive a similar increase). Although there were changes to the individual salary increases, these individual salary increases include movement up through the ranks and the payroll growth assumption is likely a better indicator of the increases associated with this type of provision. As such, we recommend no changes to the Old Hire rank escalation assumptions.

Demographic Assumptions

As previously mentioned, actuaries are guided by the Actuarial Standards of Practice (ASOP) adopted by the Actuarial Standards Board (ASB). One of these standards is ASOP No. 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*. This standard provides guidance to actuaries giving advice on selecting noneconomic assumptions for measuring obligations under defined benefit plans. We believe the recommended assumptions in this report were developed in compliance with this standard.

Post-retirement mortality rates

The longer retirees live and receive their benefits, the larger the liability of the plan, thus increasing the contributions necessary to fund the plan. We currently use the RP-2014 Combined Mortality Table with Blue Collar Adjustment for males and females, with full generational mortality projection using Scale BB for all plans under FPPA. The current assumption set was recommended in the last experience study based on the standard mortality tables available at the time and the expectation that public safety mortality experience is somewhat impaired compared to the general population (which implied the blue collar adjustment).

Credibility

When choosing an appropriate mortality assumption, actuaries typically use standard mortality tables, unlike when choosing other demographic assumptions. They may choose to adjust these standard mortality

tables, however, to reflect various characteristics of the covered group, and to provide for expectations of future mortality improvement (both up to and after the measurement date). If the plan population has sufficient credibility to justify its own mortality table, then the use of such a table also could be appropriate. Factors that may be considered in selecting and/or adjusting a mortality table include the demographics of the covered group, the size of the group, the statistical credibility of its experience, and the anticipated rate of future mortality improvement.

Based on a practice note issued by the American Academy of Actuaries in the Fall of 2011, a dataset needs 96 expected deaths for each gender to be within +/- 20% of the actual pattern with 95% confidence. We believe +/- 20% is a rather large range to be considered fully credible. Other sources state higher requirements, such as 1,000 deaths per gender per age to reach full credibility. The following table gives the number of deaths needed by gender to have a given level of confidence that the data is +/- X% of the actual pattern.

Standard Score	Confidence	99% – 101%	97% – 103%	95% – 105%	90% – 110%	80% – 120%
0.674	75%	4,543	505	182	45	11
1.282	80%	16,435	1,826	657	164	41
1.645	90%	27,060	3,007	1,082	271	68
1.96	95%	38,416	4,268	1,537	384	96
2.576	99%	66,358	7,373	2,654	664	166

Using this information, 1,082 deaths are needed by gender to have 90% confidence that the data is within +/- 5% of the actual pattern. The Old Hire Plans use a very different mortality definition than the Statewide Defined Benefit Plan. Currently the Old Hire Plans have nearly as many disability retirees as normal service retirements indicating a low threshold for disability eligibility. This low threshold for disability retirement may indicate that the remaining non-disabled service retirees would have above average life expectancy, and may not be appropriate for study of the general FPPA retiree population. The Statewide Defined Benefit plan is still a relatively young plan with a small retiree population. During the five-year period, within the Statewide Defined Benefit Plan there were substantially less than even 100 deaths, indicating very limited credibility. As such, we recommend continuing to use a standard base table.

Choosing a Base Table

Historically, it has been assumed that public safety employees would experience shorter life expectancies as compared to the general population due to the risk factors associated with the working conditions. However, this assumption has largely remained unstudied on a credible (sufficiently large) data set. In August of 2018, the Society of Actuaries released its first published study of public plan mortality data and included a study of public safety mortality versus general employees. The findings of that study indicated that male public safety experience was very similar to the RP-2014 base table (without blue collar adjustment) and male general employee experience. Female public safety experience was more similar to the RP-2014 base table with blue collar adjustment; however, females only make up about 10% of the Statewide Defined Benefit Plan member population and most of the female associated liability is due to beneficiary liabilities. Therefore, we recommend removing the blue collar adjustment from the standard table.

Recommended Mortality Improvement Assumption

We use a fully generational approach to mortality, assuming that life expectancy will continue to improve each year. Because of this strategy of building in continuous improvement, life expectancies for today's younger active members are expected to be materially longer than those of today's retirees, and this has a significant impact on costs and liabilities. We currently use Scale BB to determine the amount of life expectancy improvement.

Since we last set this assumption, there have been new projection scales published. The most recent versions include a two dimensional grid that provide different rates of improvement for each age each year for the next decade or so, before settling into an ultimate rate in the year 2027. Since the original MP-2014 scales were published, there have been three new versions published, reflecting new years of data as they have become available. In all three updates, rates of projection were materially decreased, meaning the original MP-2014 were found to be too conservative. More importantly, it has been stated that new projection scales are going to be published each year. We find this to be a very poor strategy and a misunderstanding of what assumptions in a funding valuation are used for. Consistency in results and dependable contribution patterns must have value in the process. As such, we do not recommend using the entire grid of the MP tables or annual updates of the assumptions.

We do feel it prudent to attempt to use the most recent data available, and as such, for years after the experience study, we recommend utilizing the MP tables, but only using the ultimate values once the select period is over. We are calling this Ultimate MP, or U-MP. The values in this portion of the projection scales have not changed from year to year.

Although it was called RP-"2014", the data that was used to develop the RP-2014 base table was actually from 2003 to 2009, with a central year of 2006. This data was then projected forward using MP-2014 to the base year of 2014. Because MP-2014 was later found to be overly conservative, we recommend backing out this projection, and then re-projecting from 2006 to 2018 using the most recently published MP-2017 to develop the new base table as of 2018.

This mortality recommendation applies to all healthy retirees under the FPPA system. The net impact of the proposed mortality assumptions would be a slight decrease in liabilities.

Totally Disabled mortality rates

We are recommending the RP-2014 table for disabled lives adjusted back to 2006 with MP-2014 and projected forward to 2018 using MP-2017 and fully generational mortality, projected using Scale U-MP from 2018. However, we are going to place a minimum probability of death across all of the age groups to reflect the high impairment for this population, 3% for males and 2% for females. These rates are consistent with other mortality tables for retirees with an "unable to engage in any substantial gainful activity" definition of disability.

This assumption applies to the SWDD plan and the Volunteer Plans, although it is immaterial in the case of the Volunteer Plans.

Occupationally Disabled mortality rates

The standard for Occupational Disability only requires that a participant can no longer be employed as a police officer or firefighter which is a much lower threshold than is associated with standard disabled mortality tables. Using a standard disabled mortality table would overestimate the level of impairment and underestimate the lifespan of these members. Rather than using a disabled mortality table, we recommend continuing to use the healthy retiree rates with a three year set-forward (age 60 uses age 63 rate) to reflect partial impairment. This assumption applies to the SWDD plan and the Old Hire Plans for participants disabled prior to January 1, 1980.

Active mortality rates

For non-duty death, we are recommending the 50% of RP-2014 table for active lives adjusted back to 2006 with MP-2014 and projected forward to 2018 using MP-2017 and fully generational mortality, projected using Scale U-MP from 2018. For duty death, we recommend reducing the flat rate from 0.2% per year to 0.15%. However, this is in conjunction with an increase to the marriage assumption from 85% to 100%. Making this change results in minimal impact to the valuation, but allows us to better track the gain or loss due to active death.

Disability rates

FPPA uses separate disability rates for disability type (occupational vs. total disability) and for member retirement plan type (defined benefit plan vs. money purchase plan). During the five-year study period, the money purchase occupational disability experience was similar to historical experience and the previously assumed rates. As such, we recommend no change to the money purchase occupational disability rates.

Money Purchase Plan Occupational Disability Experience				
Actual Occupational Disabilities	Expected Disabilities - Current	Expected Disabilities - Proposed	Actual/Expected - Current	Actual/Expected - Proposed
110	104	104	106%	106%

The actual number of total disabilities was less than expected for the money purchase plan members; however, because there was very little experience to justify a change in the rates and the current rates are conservative with respect to the SWD&D Plan, we recommend no change to the money purchase total disability rates.

Money Purchase Plan Total Disability Experience				
Actual Occupational Disabilities	Expected Disabilities - Current	Expected Disabilities - Proposed	Actual/Expected - Current	Actual/Expected - Proposed
6	9	9	67%	67%

Recent actual experience has substantially outpaced the historical experience and the expectations based on the current assumption set for members in the defined benefit programs. In particular, there was a sharp increase in the number of occupational disabilities within the last two years. This increase may represent natural volatility in actual experience or it could represent an underlying trend that will persist in future years. Due to the sensitivity of the SWD&D actuarial results to this assumption, and due to the slow moving nature of the funding policy's adjustment to adverse experience, we recommend fully recognizing this increased recent experience in the disability rates. We have confirmed with FPPA staff that this higher trend has continued for the first 7 months of 2018.

	Defined Benefit Plan Occupational Disability Experience				
Study Period	Actual Occupational Disabilities	Expected Disabilities - Current	Expected Disabilities - Proposed	Actual/Expected - Current	Actual/Expected - Proposed
5-year	153	105	172	146%	89%
2-year	76	42	75	181%	101%

The actual number of total disabilities was similar to expected for the defined benefit plan members considering the limited experience and we recommend no change to this assumption.

Defined Benefit Plan Total Disability Experience				
Actual Occupational Disabilities	Expected Disabilities - Current	Expected Disabilities - Proposed	Actual/Expected - Current	Actual/Expected - Proposed
18	20	20	90%	90%

Termination rates

Statewide Defined Benefit Plan and Statewide Hybrid Plan – Defined Benefit Component

Termination rates reflect members who leave for any reason other than death, disability, or service retirement. They apply whether the termination is voluntary or involuntary, and whether the member takes a refund or keeps his/her account balance on deposit. The current termination rates reflect the member's service. Actual termination rates for the Statewide Defined Benefit Plan were slightly higher than the current assumption resulting in an actual to expected ratio of 111% but generally was a good fit to the data across service levels. We recommend leaving the assumption unchanged with an A/E higher than 100% to reflect future rehires of members into other departments.

Statewide Hybrid Plan – Defined Benefit Component termination rates are set consistent with the Statewide Defined Benefit Plan.

Colorado Springs New Hire Plans

We recommend retaining the Colorado Springs New Hire Plans termination assumption of 110% of the rates based on the Statewide Defined Benefit Plan experience. The service-based rates start at higher levels and grade down over the member's tenure. Because these plans were closed in 2006 and all members have 12 years of service or more, this assumption is becoming increasingly immaterial to the projection of benefits under these plans.

Volunteer Firefighter Plans

The termination experience for the Volunteer Firefighter plans was studied based on the four-year period ending December 31, 2017 for plans that remained open to new members during this time period. The actual to expected ratio for members with less than 20 years of service was 132%. Because there may be significant variability in this experience by employer, we prefer to leave some conservatism. We recommend increasing the termination rates by 10% which results in an actual to expected ratio of 120%.

Retirement rates

Statewide Defined Benefit Plan and Statewide Hybrid Plan – Defined Benefit Component

We currently use two different sets of retirement rates. For members that are at least 55 and have at least 25 years of service (normal retirement), age-based rates are applied with 100% retirement assumed at age 60. For members that have at least five years of service, but less than 25 (early retirement), service-based rates are applied starting at age 55. It is important to note that a member entering Deferred Retirement Option Plan (DROP) appears to be a retirement in the actuarial valuation and so any reference to retirement will include members entering DROP as well as members who retire directly from active status.

We recommend continued use of the current rate structure with modest adjustment to the rates themselves. In the early retirement experience for the Statewide Defined Benefit Plan at low service levels, we saw more retirement than anticipated and recommend and increase to those rates. In the normal retirement experience at ages after 55, we saw slightly fewer retirements than expected and recommend a modest reduction in rates. The actual retirement rates starting at age 60 are substantially less than the 100% assumption, however, the actual experience or exposure becomes thinner at this point, and using the 100% rate is a conservative approach.

Statewide Hybrid Plan – Defined Benefit Component retirement rates are set consistent with the Statewide Defined Benefit Plan.

Colorado Springs New Hire Plans

The number of retirements under the Colorado Springs New Hire Plans was less than expected; however the amount of retirement data available for these plans is significantly less than desired to assign full credibility. We recommend making changes parallel to those applied to the Statewide Defined Benefit Plan normal retirement rates which will slightly reduce the number of expected retirements. For the Fire Component, there are reduced early retirement benefits offered between age 50 and 55 and we assume a 5% rate of retirement at these ages. During the five-year experience period (and in 2016 and 2017 in particular), there were substantially more early retirements than expected using the 5% assumption

producing a 250% actual to expected ratio. Due to the limited credibility of the data, we recommend moving from a 5% rate to a 7.5% rate which reduces the actual to expected ratio down to 167%.

Volunteer Firefighter Plans

The Volunteer Firefighter valuations assume 50% of members eligible to retire in a given year will retire, until age 65 when 100% retirement is assumed. Based on the 2015 valuation results, 227 retirements were expected during the 2015 and 2016 calendar years. During that time there were 227 actual retirements resulting in an actual to expected ratio of 100%. We recommend no change to this assumption.

Other assumptions

Spouse Assumption – Statewide Defined Benefit Plan

As mentioned in the active mortality section, we recommend changing the assumption regarding the percentage of members that are married or in a civil union from 85 to 100%. However, this is in conjunction with a reduction to the active mortality rates. While this change does not have a large impact on the results, it does help better align the assumptions with the data that we receive since an active death may simply appear as a refund in cases where no spouse or civil union partner is available to collect a death benefit.

Spouse Assumption – Colorado Springs New Hire Plans

The spouse assumption is more material for the Colorado Springs New Hire Plans because those plans offer a subsidized post-retirement death benefit for married participants. Data for recent retirements indicates slightly less than 85% of members were married at retirement. We recommend keeping the 85% marriage assumption for purposes of valuing the post-retirement death benefit to maintain some margin of conservatism and to account for possible re-marriage post-retirement.

Spouse Assumption - Volunteer Fire Plans

Similarly, the spouse assumption is material for the Volunteer Fire Plans because they offer a subsidized post-retirement death benefit. Data for recent retirements indicates less than 90% of members were married at retirement. We recommend keeping the 90% marriage assumption for purposes of valuing the post-retirement death benefit to maintain some margin of conservatism, to account for possible re-marriage post-retirement, and to account for potential variability by employer.

Other Assumptions

There are other assumptions made in the course of a valuation that make up the full assumption set used. We have thoroughly reviewed all of these ancillary assumptions, and believe they are generally appropriate and reasonable. Therefore, we recommend no changes to these other assumptions. A listing of all of these assumptions is in Section E.

Actuarial methods

While the SWDB and SWH-DB plans are currently overfunded and thus an amortization period is not applicable to the valuation process, when it has historically been used, the period has been 30 years. Based on new requirements in the Actuarial Standards of Practice, the combined use of level percentage of payroll financing and a rolling 30 year amortization period will no longer be a reasonable policy. For determining the ADEC in future valuations, we will use a period that does not produce negative amortization, which will likely be approximately 20 years.

In conjunction with outcomes of the asset allocation study for the Old Hire Plans, there may be recommended changes to the current policy in setting the Actuarially Determined Contribution.

We recommend no change to any of the other actuarial methods being used.

Administrative procedures

We have reviewed the current processes used to determine default ages, salaries, genders, etc. for missing or inconsistent data and recommend no changes.

SECTION D

ACTUARIAL IMPACT OF RECOMMENDATIONS

Estimated Actuarial Impact of Recommendations

For illustrative purposes, the tables shown below show the impact of the proposed assumption changes on the results of the most recent valuations.

Statewide Defined Benefit Plan Valuation Results as of January 1, 2018 ($ in millions)				
	Current	**All Proposed except ROA**	**Proposed @ 7.25%**	**Proposed @ 7.00%**
Normal cost	15.20%	14.95%	15.77%	16.65%
Unfunded actuarial accrued liability (UAAL)	($84)	($109)	($40)	$32
Funded ratio	103.70%	104.80%	101.70%	98.70%
Actuarially Determined Contribution (ADC)	14.40%	13.91%	15.40%	17.03%
Est Breakeven COLA in 2018	0.39%	0.53%	0.14%	-0.21%
Est Breakeven COLA in 2035	1.51%	1.78%	1.34%	0.90%

Statewide Death and Disability Plan Valuation Results as of January 1, 2018 ($ in millions)				
	Current	**All Proposed except ROA**	**Proposed @ 7.25%**	**Proposed @ 7.00%**
Normal cost (EAN)	2.78%	3.57%	3.70%	3.82%
Unfunded actuarial accrued liability (UAAL)	($9)	$80	$103	$127
Funded ratio	102.20%	83.10%	79.30%	75.70%
Aggregate Funding Cost	2.69%	3.74%	3.99%	4.24%
Est Breakeven COLA in 2018	0.01%	0.00%	0.00%	0.00%

Statewide Hybrid Plan - Defined Benefit Component Valuation Results as of January 1, 2018 ($ in millions)			
	Current	**Proposed @ 7.25%**	**Proposed @ 7.00%**
Normal cost	10.04%	10.28%	10.84%
Unfunded actuarial accrued liability (UAAL)	($18)	($17)	($16)
Funded ratio	135.55%	133.97%	130.47%
Actuarially Determined Contribution (ADC)	3.62%	4.08%	5.13%
Est Breakeven COLA in 2018	3.00%	3.00%	2.66%

Sample Old Hire Plans Valuation Results as of January 1, 2018 ($ in millions)			
Result	**Current Assumptions**	**Recommended Assumptions - 7.25%**	**Recommended Assumptions - 7.00%**
Aurora Police - long amortization			
Actuarial accrued liability	$135.681	$139.102	$142.571
Actuarial value of assets	$92.942	$92.942	$92.942
Unfunded actuarial accrued liability	$42.739	$46.160	$49.629
Funded ratio	68.5%	66.8%	65.2%
Administrative expenses	$0.096	$0.096	$0.096
20-Year ADC	$4.165	$4.435	$4.697
Mountain View Fire - short amortization			
Actuarial accrued liability	$0.332	$0.320	$0.328
Actuarial value of assets	$0.280	$0.280	$0.280
Unfunded actuarial accrued liability	$0.052	$0.040	$0.048
Funded ratio	84.3%	87.5%	85.4%
Administrative expenses	$0.002	$0.002	$0.002
7-Year ADC	$0.013	$0.010	$0.012

Colorado Springs New Hire Plans Valuation Results as of January 1, 2018 ($ in millions)			
Result	**Current Assumptions**	**Recommended Assumptions - 7.25% Interest**	**Recommended Assumptions - 7.00% Interest**
Fire Component			
Actuarial accrued liability	$168.49	$171.99	$177.40
Actuarial value of assets	$139.08	$139.08	$139.08
Unfunded actuarial accrued liability	$29.41	$32.91	$38.32
Funded ratio	82.5%	80.9%	78.4%
Normal Cost	$1.71	$1.79	$1.91
Administrative expenses	$0.07	$0.07	$0.07
20-Year ARC	$4.52	$4.92	$5.53
Police Component			
Actuarial accrued liability	$342.82	$350.47	$362.38
Actuarial value of assets	$308.03	$308.03	$308.03
Unfunded actuarial accrued liability	$34.78	$42.44	$54.35
Funded ratio	89.9%	87.9%	85.0%
Normal Cost	$4.73	$5.01	$5.34
Administrative expenses	$0.13	$0.13	$0.13
20-Year ARC	$8.04	$9.05	$10.54

Sample Volunteer Plans Valuation Results as of January 1, 2017 ($ in thousands)			
Result	**Current Assumptions**	**Recommended Assumptions - 7.25%**	**Recommended Assumptions - 7.00%**
Telluride Fire Protection District			
Actuarial accrued liability	$2,940.89	$2,996.59	$3,071.03
Actuarial value of assets	$2,015.29	$2,015.29	$2,015.29
Unfunded actuarial accrued liability	$925.61	$981.31	$1,055.74
Funded ratio	68.5%	67.3%	65.6%
Normal Cost	$28.38	$26.76	$28.33
Administrative expenses	$4.04	$4.04	$4.04
20-Year ARC	$112.78	$115.11	$122.61
Brighton (Retiree Only, nearly fully funded)			
Actuarial accrued liability	$3,927.66	$3,986.92	$4,072.36
Actuarial value of assets	$3,731.00	$3,731.00	$3,731.00
Unfunded actuarial accrued liability	$196.66	$255.92	$341.36
Funded ratio	95.0%	93.6%	91.6%
Administrative expenses	$9.99	$9.99	$9.99
14-Year ARC	$18.75	$24.62	$32.94

SECTION E

SUMMARY OF ASSUMPTIONS AND METHODS INCORPORATING THE RECOMMENDED ASSUMPTIONS

Summary of Actuarial Methods and Assumptions

The following presents a summary of the actuarial assumptions and methods used in the valuation of the SWDB, SWH-DB and the SWDD. This report focuses on those two plans because the assumptions and methods derived from those two plans translate well to the other plans covered under FPPA. Additional information regarding assumptions specific to the Volunteer Plan and Colorado Springs New Hire Plans can be found on pages 42 and 43.

I. Valuation Date

The valuation date is January 1st of each plan year. This is the date as of which the actuarial present value of future benefits and the actuarial value of assets are determined.

II. Actuarial Cost Method

The SWDB and SWH-DB actuarial valuation use the Entry Age Normal actuarial cost method. Under this method, the employer contribution rate is the sum of (i) the employer normal cost rate, and (ii) a rate that will amortize the unfunded actuarial liability.

1. The valuation is prepared on the projected benefit basis. The present value of each participant's expected benefit payable at retirement or termination is determined, based on age, service, sex, compensation, and the interest rate assumed to be earned in the future (7.25% or 7.00%). The calculations take into account the probability of a participant's death or termination of employment prior to becoming eligible for a benefit, as well as the possibility of his terminating with a service benefit. Future salary increases are also anticipated. The present value of the expected benefits payable on account of the active participants is added to the present value of the expected future payments to retired participants and beneficiaries to obtain the present value of all expected benefits payable from the Plan on account of the present group of participants and beneficiaries.

2. The employer contributions required to support the benefits of the Plan are determined following a level funding approach, and consist of a normal cost contribution and an accrued liability contribution.

3. The normal cost contribution is determined using the Entry Age Normal method. Under this method, a calculation is made to determine the average uniform and constant percentage rate of employer contribution which, if applied to the compensation of each new participant during the entire period of his anticipated covered service, would be required in addition to the contributions of the participant to meet the cost of all benefits payable on their behalf.

4. The unfunded accrued liability contributions are determined by subtracting the actuarial value of assets from the actuarial accrued liability. In cases of surplus, this amount is amortized over 30 years. In cases of unfunded liability, this amount is amortized over a period such that the amortization provides for at least the interest accruing on the unfunded liability during the year. It is assumed that payments are made monthly throughout the year.

The SWDD actuarial valuation uses the Aggregate Funding Method. Under this method, the contribution rate is calculated to fully fund the present value of all benefits over the remaining working career of the active employees. The contribution rate is determined as a percentage of increasing payroll.

1. The valuation is prepared on the projected benefit basis. The present value of each participant's expected benefit payable at retirement or termination is determined, based on age, service, sex, compensation, and the interest rate assumed to be earned in the future (7.25% or 7.00%). The calculations take into account the probability of a participant's death or termination of employment prior to becoming eligible for a benefit, as well as the possibility of his terminating with a service benefit. Future salary increases are also anticipated. The present value of the expected benefits payable on account of the active participants is added to the present value of the expected future payments to retired participants and beneficiaries to obtain the present value of all expected benefits payable from the Plan on account of the present group of participants and beneficiaries.

2. The actuarial value of assets is subtracted from the present value of all expected benefits to determine the present value of future normal costs. The future normal costs are spread across the future value of salaries to be paid to the current active population to determine a contribution rate.

III. Actuarial Value of Assets

The actuarial value of assets is equal to the market value of assets less a five-year phase in of the excess (shortfall) between expected investment return and actual income. The actual calculation is based on the difference between actual earnings and expected earnings each year, and recognizes the cumulative excess return (or shortfall) over at a minimum rate of 20% per year. The speed of the recognition will increase if the Plan continues to be in the same net deferred position (net gain or net loss) from one year to the next. This is intended to ensure the smoothed value of assets will converge towards the market value in a reasonable amount of time. In addition, a gain or loss that is in the opposite direction of the current net position will be immediately recognized.

Expected earnings are determined using the assumed investment return rate and the beginning of year actuarial value of assets (adjusted for receipts and disbursements during the year). The returns are computed net of administrative and investment expenses.

IV. Actuarial Assumptions

A. Economic Assumptions

1. Investment return: (7.25% or 7.00%) per annum, compounded annually, composed of an assumed 2.50% inflation rate and a (4.75% or 4.50%) real rate of return. This rate represents the assumed return, net of all investment expenses.

2. Salary increase rate: Inflation rate of 2.50%, plus productivity component of 1.75%, plus step-rate/ promotional component as shown:

Years of Service	Annual Step-rate/ Promotional Rate	Total Annual Rate of Increase Including 2.50% Inflation Component and 1.75% Productivity Component
(1)	(2)	(3)
1	7.00%	11.25%
2	7.00%	11.25%
3	6.50%	10.75%
4	6.00%	10.25%
5	3.50%	7.75%
6	1.50%	5.75%
7	1.50%	5.75%
8	1.00%	5.25%
9	1.00%	5.25%
10	0.75%	5.00%
11	0.75%	5.00%
12	0.50%	4.75%
13	0.50%	4.75%
14	0.25%	4.50%
15	0.00%	4.25%

Salary increases are assumed to occur once a year, on January 1. Therefore the pay used for the period between the valuation date and the first anniversary of the valuation date is equal to the reported pay for the prior year, annualized if necessary, and then increased by the salary increase assumption.

3. Payroll growth rate: In the amortization of the unfunded actuarial accrued liability, payroll is assumed to increase 3.50% per year. This increase rate is primarily due to the effect of inflation on salaries, with no allowance for future membership growth.

B. Demographic Assumptions

1. Mortality rates (members in payment status) –

a. Healthy retirees and beneficiaries: 2006 central rates from the RP-2014 Annuitant Mortality Tables for males and females projected to 2018 using the MP-2017 projection scales, and then projected prospectively using the ultimate rates of the scale for all years.

	Annual Rate per 1,000 Members				
Attained Age in 2018	Males	Females	Attained Age in 2018 (cont.)	Males	Females
(1)	(2)	(3)	(4)	(5)	(6)
50	4.06	2.74	70	17.35	13.13
55	5.82	3.85	75	27.70	21.57
60	8.17	5.75	80	46.78	36.91
65	11.70	8.49	85	81.96	65.96

b. Occupationally disabled retirees: Healthy retiree tables set forward three years.

	Annual Rate per 1,000 Members				
Attained Age in 2018	Males	Females	Attained Age in 2018 (cont.)	Males	Females
(1)	(2)	(3)	(4)	(5)	(6)
50	5.10	3.30	70	22.79	17.60
55	7.11	4.90	75	37.73	29.60
60	10.12	7.27	80	65.29	52.13
65	14.69	10.93	85	115.26	93.69

c. Totally disabled retirees: 2006 central rates from the RP-2014 Disabled Mortality Tables for males and females projected to 2018 using the MP-2017 projection scales, and then projected prospectively using the ultimate rates of the scale for all years, with minimum probability of 3% for males and 2% for females.

	Annual Rate per 1,000 Members				
Attained Age in 2018	Males	Females	Attained Age in 2018 (cont.)	Males	Females
(1)	(2)	(3)	(4)	(5)	(6)
50	30.00	20.00	70	41.74	28.78
55	30.00	20.00	75	56.06	42.28
60	30.00	20.00	80	80.14	64.66
65	33.66	22.01	85	119.83	98.57

2. Mortality rates (active members) – 2006 central rates from the RP-2014 Employee Mortality Tables for males and females projected to 2018 using the MP-2017 projection scales, and then projected prospectively using the ultimate rates of the scale for all years, 50% multiplier for off-duty mortality. Increased by 0.00015 for on-duty related Fire and Police experience. Sample rates are shown below:

	Annual Rate per 1,000 Members				
Attained Age in 2018	Males	Females	Attained Age in 2018 (cont.)	Males	Females
(1)	(2)	(3)	(4)	(5)	(6)
20	0.34	0.23	40	0.50	0.38
25	0.40	0.24	45	0.65	0.49
30	0.40	0.27	50	0.99	0.69
35	0.45	0.31	55	1.57	1.04

3. Disability rates: Sample rates are shown below by age and disability type.

	Annual Rate per 1,000 Members			
Age	Occupational Disability Rates (MP)	Occupational Disability Rates (SWDB)	Total Disability Rates (MP)	Total Disability Rates (SWDB)
(1)	(2)	(3)	(4)	(5)
25	0.25	0.48	0.01	0.02
30	1.18	2.26	0.11	0.17
35	1.60	3.05	0.23	0.34
40	2.35	4.48	0.35	0.52
45	4.09	5.53	0.48	0.72
50	8.86	8.22	0.63	0.94
55	15.53	11.56	0.78	1.17

4. Termination rates (for causes other than death, disability or retirement): Termination rates are based on service. Termination rates are not applied after a member becomes eligible for a retirement benefit. Rates at selected ages are shown:

	Annual Rate per 1,000 Members				
Service	Rates	Service (cont.)	Rates	Service (cont.)	Rates
0	98.5	8	25.5	16	9.4
1	84.6	9	21.3	17	9.1
2	72.3	10	17.9	18	8.8
3	61.4	11	15.3	19	8.5
4	51.9	12	13.3	20	8.1
5	43.6	13	11.7	21	7.5
6	36.5	14	10.7	22	6.5
7	30.5	15	9.9	23	5.2

5. Retirement rates:

Members of the SWDD Plan are assumed to retire at the time of attaining:

A. Statewide Defined Benefit Plan Members and other New Hire Plan Members: Age 55 with 22 years of service or current age, if greater.

B. Money Purchase Plan Members: The earliest of Age 65 or Age 55 with 25 years of service; or current age, if greater. For members age 55 with less than 25 years of service, service-based rates consistent with the SWDB service-based rates shown below.

C. Denver Police Old Hire Plan Members: Age after 25 years of service, or current age, if greater.

D. Denver Fire Old Hire Plan Members: Age 50 and 25 years of service, or current age, if greater.

E. All Other Plan members: Age 52 or current age, if greater.

Age-Based Retirement rates, for SWDB members with more than 25 years of service

Age	Annual Rate per 100 Members
55	60
56-59	45
60	100

Service-Based Retirement rates for SWDB members*

Service	Annual Rate per 100 Members
5-12	6
13	7
14	8
15	9
16	9
17	10
18	11
19	12
20	13
21	15
22	20
23-24	25

*Rates first applied at age 55; 100 percent retirement assumed at age 70.

C. Other Assumptions

1. Administrative expenses: Based on actual administrative expenses paid in the prior year.

2. Percent married: 100% of employees are assumed to be married or in a civil union.

3. Age difference: Male members are assumed to be two years older than their spouses, and female members are assumed to be two years younger than their spouses.

4. Cost of living escalators (COLA): Current Law – 0%.

5. Percent electing annuity on death (when eligible): All of the spouses of vested, married participants are assumed to elect an annuity.

6. Percent electing deferred termination benefit: Vested terminating members are assumed to elect a refund or a deferred benefit, whichever is more valuable at the time of termination.

7. For the SWDB plan, 10% of members who become occupationally disabled after the age of 50 will transfer back to the SWDB plan at age 55.

8. No surviving spouse will remarry and there will be no children's benefit.

9. Assumed age for commencement of deferred benefits: Members electing to receive a deferred benefit are assumed to commence receipt at the first age at which unreduced benefits are available.

10. Pay increase timing: Beginning of (fiscal) year. This is equivalent to assuming that reported pays represent amounts paid to members during the year ended on the valuation date.

11. Decrement timing: Decrements of all types are assumed to occur mid-year.

12. Eligibility testing: Eligibility for benefits is determined based upon the age nearest birthday and service nearest whole year on the date the decrement is assumed to occur.

13. Decrement relativity: Decrement rates are used directly from the experience study, without adjustment for multiple decrement table effects.

14. Incidence of Contributions: Contributions are assumed to be received continuously throughout the year based upon the computed percent of payroll shown in this report, and the actual payroll payable at the time contributions are made.

15. Benefit Service: All members are assumed to accrue 1 year of service each year. Exact fractional service is used to determine the amount of benefit payable.

16. Inactive Population: All members included in the inactive non-vested population with at least 10 years of service are valued using two times member contributions.

D. Participant Data

Participant data was supplied on electronic files in the form of spreadsheets. There were separate tabs for (i) active and non-vested inactive members, and (ii) members and beneficiaries receiving benefits or vested inactives.

The data for active members included birthdate, sex, service, salary and employee contribution account balance. For retired members and beneficiaries, the data included date of birth, sex, spouse's date of birth (where applicable), amount of monthly benefit, date of retirement, and a form of payment code.

Salary supplied for the current year was based on the earnings for the year preceding the valuation date adjusted for service accrued during the year. In cases where the earnings for the year two years prior to the valuation date was higher, this higher amount was used. This salary was adjusted by the salary increase rate for one year.

Assumptions were made to correct for missing, bad, or inconsistent data. These had no material impact on the results presented.

E. Allocation to SRA

The SRA contribution rate is determined annually based on the normal cost plus amortization of unfunded liability (surplus). The excess of the total contribution rate (18.00% in 2018, ratcheted up by 0.50% until reaching 20.0% in 2022) over the actuarial requirement is available as the SRA contribution rate. The Board has the authority and responsibility to choose the SRA rate. Other considerations may be evaluated such as:

1. Investment performance subsequent to the actuarial valuation
2. Potential future plan changes under consideration
3. Stability of SRA
4. Projections of future SRA contributions
5. Ability to grant future benefit adjustments to retired members

Summary of Alternate Actuarial Methods and Assumptions

The following presents a summary of any actuarial assumptions and methods used in the valuation of the Volunteer, Old Hire, and Colorado Springs New Hire Plans where the assumptions do not translate directly from the SWDB and SWDD assumptions.

Colorado Springs New Hire – Fire Component:

Age-Based Retirement rates, for CS NH Fire members with more than 25 years of service

Age	Annual Rate per 100 Members
55	60
56-59	45
60	100

Members eligible for early retirement have a 7.5% rate of retirement applied starting at age 50.

Termination rates are 110% of the SWDB plan rates.

Percent married: For purposes of valuing the post-retirement death benefit, 85% of employees are assumed to be married or in a civil union.

Colorado Springs New Hire – Police Component:

Age-Based Retirement rates, for CS NH Police members with more than 25 years of service

Age	Annual Rate per 100 Members
50	60
51-54	45
55	100

*Rates first applied at age 50; 100 percent retirement assumed at age 70.

Early retirement rates are set equal to termination rates. 10% early retirement rates for members hired on or after October 1, 2013.

Termination rates are 110% of the SWDB plan rates.

Percent married: For purposes of valuing the post-retirement death benefit, 85% of employees are assumed to be married or in a civil union.

Volunteer Fire:

Retirement — Age 50 and 20 years of service.

Age	Annual Rate Per 100
50	50
55	50
60	50
65	100

Withdrawal (any reason other than retirement, death, or disability)

Annual Rate Per 1,000 Withdrawals			
Service	Rates	Service	Rates
1	182.37	11	83.96
2	169.99	12	77.23
3	158.17	13	71.06
4	146.92	14	65.45
5	136.24	15	60.41
6	126.12	16	55.94
7	116.56	17	52.02
8	107.56	18	48.68
9	99.13	19	45.89
10	91.27		

Twenty percent (20%) of members age 50 and eligible for a terminated vested benefit which would commence immediately are assumed to withdraw each year.

Percent married: For purposes of valuing the post-retirement death benefit, 90% of employees are assumed to be married or in a civil union.

Administrative expenses: Based on average actual administrative expenses paid in the prior two years.

Old Hire Plans:

Administrative expenses: Based on average actual administrative expenses paid in the prior two years.

SECTION F

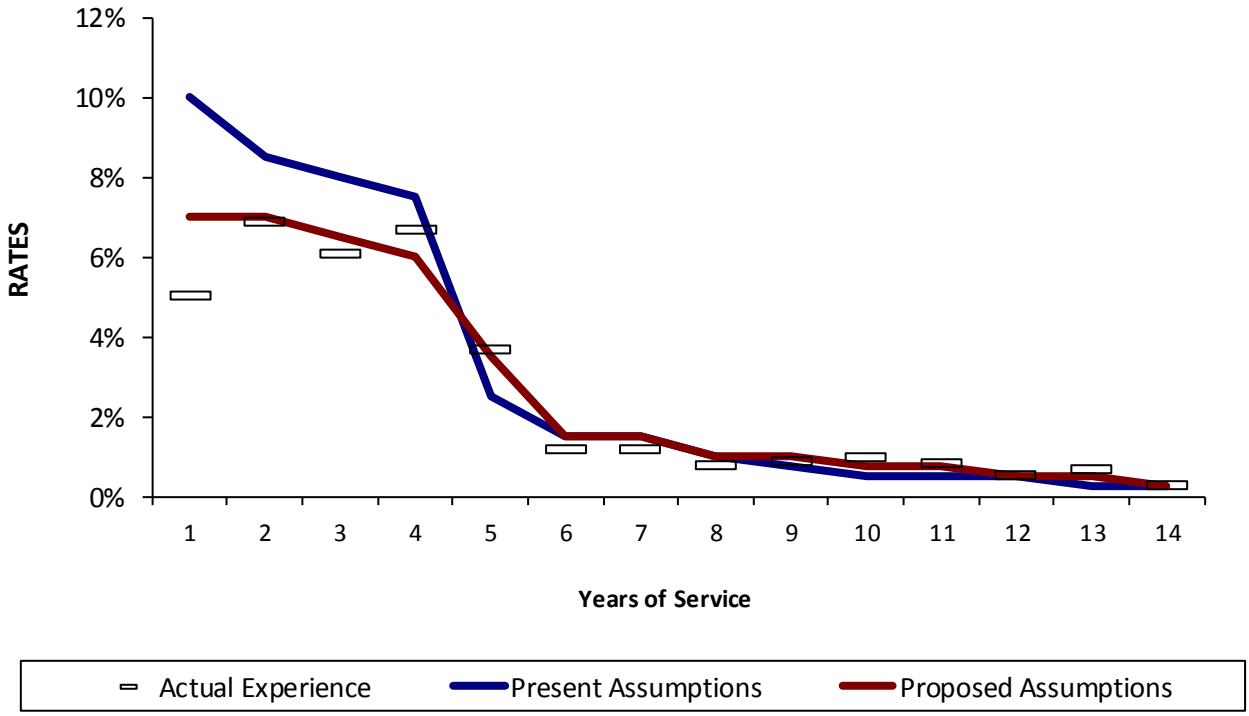
SUMMARY OF DATA AND EXPERIENCE

Statewide Defined Benefit Plan
Service-Based Salary Experience

	Current Salary Scale		Actual Experience			Proposed Salary Scale	
Years of Service	Total	Step Rate/ Promotional	Total	Above Inflation	Step Rate/ Promotional	Total	Step Rate/ Promotional
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	14.00%	10.00%	**8.92%**	7.31%	5.06%	**11.25%**	7.00%
2	12.50%	8.50%	**10.74%**	9.13%	6.88%	**11.25%**	7.00%
3	12.00%	8.00%	**9.96%**	8.35%	6.10%	**10.75%**	6.50%
4	11.50%	7.50%	**10.55%**	8.93%	6.68%	**10.25%**	6.00%
5	6.50%	2.50%	**7.57%**	5.96%	3.71%	**7.75%**	3.50%
6	5.50%	1.50%	**5.05%**	3.43%	1.18%	**5.75%**	1.50%
7	5.50%	1.50%	**5.05%**	3.43%	1.18%	**5.75%**	1.50%
8	5.00%	1.00%	**4.63%**	3.02%	0.77%	**5.25%**	1.00%
9	4.75%	0.75%	**4.76%**	3.14%	0.89%	**5.25%**	1.00%
10	4.50%	0.50%	**4.84%**	3.22%	0.97%	**5.00%**	0.75%
11	4.50%	0.50%	**4.72%**	3.10%	0.86%	**5.00%**	0.75%
12	4.50%	0.50%	**4.41%**	2.79%	0.54%	**4.75%**	0.50%
13	4.25%	0.25%	**4.54%**	2.92%	0.67%	**4.75%**	0.50%
14	4.25%	0.25%	**4.14%**	2.52%	0.27%	**4.50%**	0.25%
15	4.00%	0.00%	**3.87%**	2.25%	0.00%	**4.25%**	0.00%
16	4.00%	0.00%				**4.25%**	0.00%

Current Inflation Assumption	2.50%	Proposed Inflation Assumption	2.50%
Current Productivity Component	1.50%	Proposed Productivity/Merit Component	1.75%
Actual CPI-U Inflation for Dec/07 - Dec/17	1.62%		
Apparent Productivity/Merit Component	2.25%		

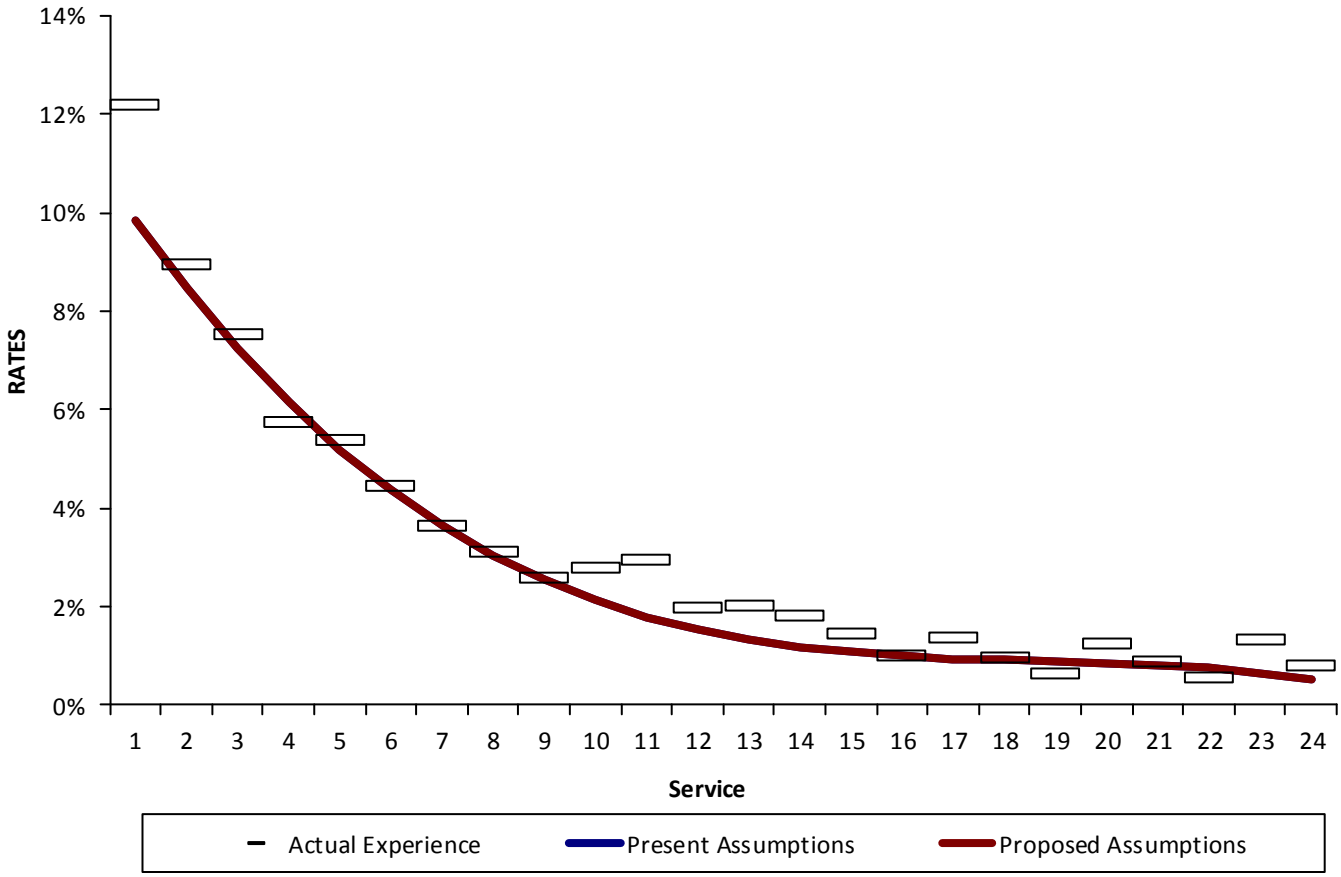
Statewide Defined Benefit Plan
Service-Based Salary Experience



Statewide Defined Benefit Plan
Service-Based Termination Experience

				Assumed Rate		Expected Withdrawal		Actual/Expected	
Service	Actual Withdrawal	Total Count	Actual Rate	Current	Proposed	Current	Proposed	Current (2) / (7)	Proposed (2) / (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	302	2,473	0.1221	0.0985	0.0985	244	244	124%	124%
2	389	4,332	0.0898	0.0846	0.0846	367	367	106%	106%
3	282	3,734	0.0755	0.0723	0.0723	270	270	104%	104%
4	199	3,440	0.0578	0.0614	0.0614	211	211	94%	94%
5	168	3,118	0.0539	0.0519	0.0519	162	162	104%	104%
6	126	2,828	0.0446	0.0436	0.0436	123	123	102%	102%
7	101	2,746	0.0368	0.0365	0.0365	100	100	101%	101%
8	87	2,764	0.0315	0.0305	0.0305	84	84	103%	103%
9	74	2,825	0.0262	0.0255	0.0255	72	72	103%	103%
10	78	2,783	0.0280	0.0213	0.0213	59	59	132%	132%
11	78	2,642	0.0295	0.0179	0.0179	47	47	165%	165%
12	47	2,366	0.0199	0.0153	0.0153	36	36	130%	130%
13	45	2,214	0.0203	0.0133	0.0133	29	29	153%	153%
14	37	2,012	0.0184	0.0117	0.0117	24	24	157%	157%
15	28	1,883	0.0149	0.0107	0.0107	20	20	139%	139%
16	18	1,747	0.0103	0.0099	0.0099	17	17	104%	104%
17	23	1,658	0.0139	0.0094	0.0094	16	16	147%	147%
18	15	1,505	0.0100	0.0091	0.0091	14	14	110%	110%
19	9	1,352	0.0067	0.0088	0.0088	12	12	75%	75%
20	16	1,245	0.0129	0.0085	0.0085	11	11	151%	151%
21	10	1,100	0.0091	0.0081	0.0081	9	9	112%	112%
22	6	1,033	0.0058	0.0075	0.0075	8	8	78%	78%
23	13	961	0.0135	0.0065	0.0065	6	6	207%	207%
24	7	851	0.0082	0.0052	0.0052	4	4	158%	158%
25	11	763	0.0144	0.0034	0.0034	3	3	424%	424%
Totals	2,169	54,375				1,948	1,948	111%	111%

Statewide Defined Benefit Plan
Service-Based Termination Experience



Statewide Defined Benefit Plan
Early (<25 yos) Retirement Experience

				Assumed Rate		Expected Retirement		Actual/Expected	
Service	Actual Retirement	Total Count	Actual Rate	Current	Proposed	Current (3) * (5)	Proposed (3) * (6)	Current (2) / (7)	Proposed (2) / (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
5	2	38	0.053	0.040	0.060	2	2	132%	88%
6	6	42	0.143	0.040	0.060	2	3	357%	238%
7	4	45	0.089	0.040	0.060	2	3	222%	148%
8	4	56	0.071	0.040	0.060	2	3	179%	119%
9	5	69	0.072	0.040	0.060	3	4	181%	121%
10	5	76	0.066	0.040	0.060	3	5	164%	110%
11	7	70	0.100	0.050	0.060	4	4	200%	167%
12	3	73	0.041	0.060	0.060	4	4	68%	68%
13	3	72	0.042	0.070	0.070	5	5	60%	60%
14	6	72	0.083	0.080	0.080	6	6	104%	104%
15	5	82	0.061	0.090	0.090	7	7	68%	68%
16	8	81	0.099	0.100	0.090	8	7	99%	110%
17	4	76	0.053	0.110	0.100	8	8	48%	53%
18	6	75	0.080	0.120	0.110	9	8	67%	73%
19	6	76	0.079	0.130	0.120	10	9	61%	66%
20	10	83	0.120	0.150	0.130	12	11	80%	93%
21	12	82	0.146	0.200	0.150	16	12	73%	98%
22	15	89	0.169	0.250	0.200	22	18	67%	84%
23	23	96	0.240	0.250	0.250	24	24	96%	96%
24	24	105	0.229	0.250	0.250	26	26	91%	91%
Totals	158	1,458	0.108			176	170	90%	93%

Statewide Defined Benefit Plan
Normal Retirement Experience

					Assumed Rate		Expected Retirement		Actual/Expected	
Age	Actual Retirement		Total Count	Actual Rate	Current	Proposed	Current (3) * (5)	Proposed (3) * (6)	Current (2) / (7)	Proposed (2) / (8)
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
55	183	***	311	0.588	0.600	0.600	187	187	98%	98%
56	69		158	0.437	0.500	0.450	79	71	87%	97%
57	46		120	0.383	0.500	0.450	60	54	77%	85%
58	32		90	0.356	0.500	0.450	45	41	71%	78%
59	24		66	0.364	0.500	0.450	33	30	73%	80%
Subtotal	354		745	0.475			404	383	88%	92%
60-64	72		129	0.558	1.000	1.000	129	129	56%	56%
65-69	6		15	0.400	1.000	1.000	15	15	40%	40%
70-74	1		8	0.125	1.000	1.000	8	8	13%	13%
Subtotal	433		897	0.483			556	535	78%	81%