VRS Stress Test and Sensitivity Analysis

Report to the General Assembly of Virginia

Virginia Retirement System

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STRESS TEST MANDATE

House Bill 1768 (Chapter 639 of the 2017 Acts of Assembly) requires the Virginia Retirement System to formally adopt a policy to regularly report sensitivity and stress testing analyses for members of the General Assembly. (Appendix A) The analyses shall include projections of benefit levels, pension costs, liabilities, and debt reduction under various economic and investment scenarios.

This report provides a risk assessment of VRS-administered retirement plans and supports the General Assembly's efforts to increase information related to the future health of the retirement system under various scenarios.

This initial report focuses on identification, quantification, and analysis of financial risks.

PENSION FUNDING BASICS

A short review of fundamentals will help establish a vocabulary and framework for the financial risk analysis related to pensions.

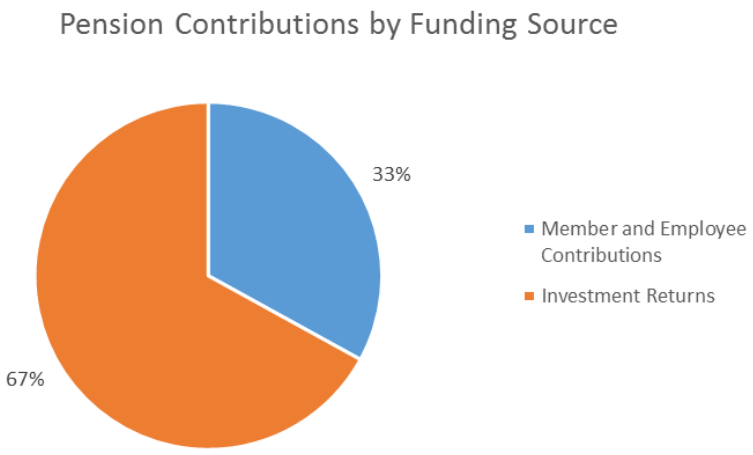
Pensions are funded by contributions and investment returns

Pensions are a promise today to pay a lifetime benefit in the future. Because of the long time horizon between the promise and the payout there is an opportunity to take advantage of the time value of money.

Income for VRS plans comes from two sources: contributions and investment income. Contributions to VRS plans are shared between employers and employees. Pension contributions are collected as a percentage of each employee paycheck and regularly deposited into the pension trust fund. The allocation of pension costs between employers and employees depends on the cost-sharing policy for the pension plan. For VRS-administered defined benefit plans employees currently pay a fixed 5% of compensation with the employer picking up the balance of the cost. Hybrid plan members also contribute 5% of compensation with 4% going to defined benefit component and 1% going to the defined contribution component of the plan.

The second source of income for pension plans comes from investment returns on employer and member contributions. The expected income from investment returns is estimated to cover roughly 67 percent of pension costs.

Exhibit 1

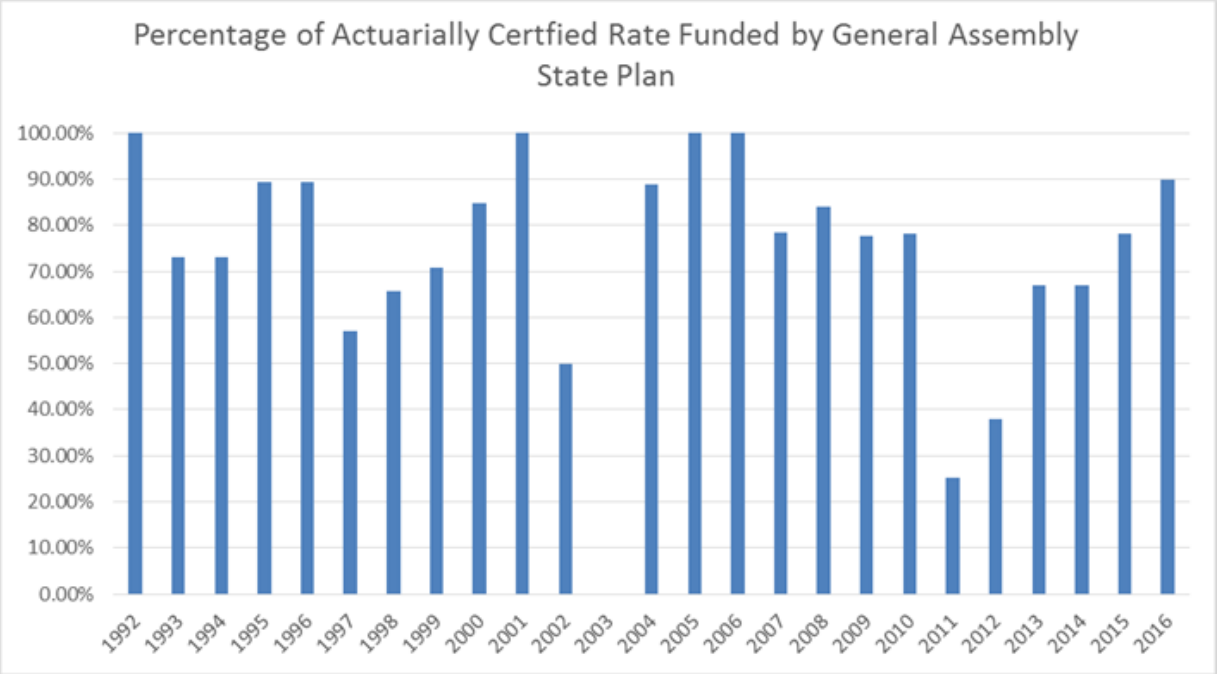


Funding policy drives how much income is received from contributions

The VRS Board of Trustees has responsibility for setting the retirement plan funding policy and adopting contribution rates for the plans based on recommendations from the plan actuary. The recommended contribution rates for the state-wide retirement systems are communicated to the General Assembly, which has the final funding authority for the funding of these plans.

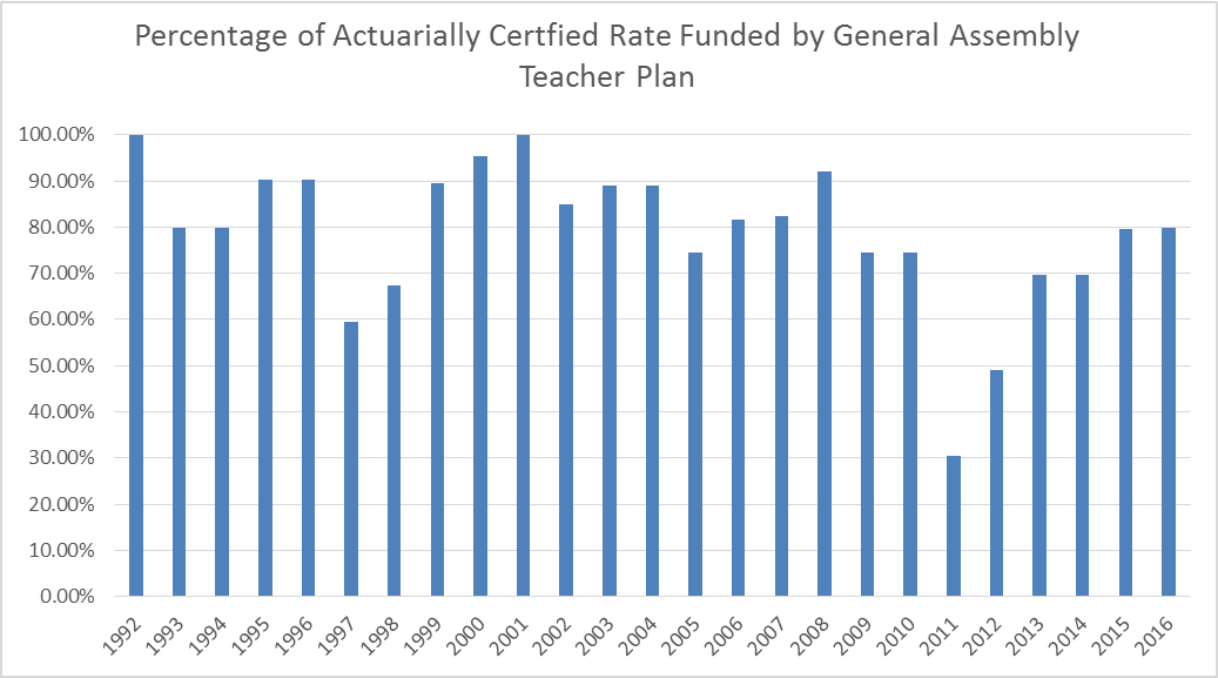
Since 1992, the full actuarially determined contribution for the State plan has only been funded three times by the General Assembly, with the average amount contributed being approximately 72% of the required rate.

Exhibit 2



Similarly, the full actuarially determined contribution for the Teacher plan has only been funded once since 1992 with the average amount contributed being approximately 78% of the required rate.

Exhibit 3



Plans established by political subdivisions and administered by VRS are required by statute to fund 100% of the actuarially determined contribution rate.

Investment policy drives how much income is derived from investments

The VRS Board of Trustees decides how to invest the contributions that are regularly deposited into the pension trust fund. Using the authority delegated to it from the General Assembly, the Board decides how to maximize investment returns at a prudent level of risk by developing an “investment policy."

The VRS Board of Trustees adopts the long-term annual rate of return assumption for investments. The assumption is used to calculate contribution rates for the plans. As such, it becomes the investment "target" for the trust fund.

Because investment earnings account for a majority of revenue for a typical public pension fund, the accuracy of the return assumption has a major effect on a plan’s

finances and actuarial funding level. An investment return assumption that is set too low will overstate liabilities and costs, causing current taxpayers to be overcharged and future taxpayers to be undercharged. A rate set too high will understate liabilities, undercharging current taxpayers, at the expense of future taxpayers. An assumption that is significantly wrong in either direction will cause a misallocation of resources and unfairly distribute costs among generations of taxpayers.

The current long-term annual rate of return assumption used by VRS is 7.0 percent. A recent plan survey by the National Association of State Retirement Administrators (NASRA) indicated that the average rate of return assumption for the 127 public plans surveyed was 7.52% as of February 1, 2017.

The VRS Investment Department strategically allocates the pension trust fund assets among different classes of investments, such as public equity, fixed income, real assets, private equity and credit in order to meet the investment target based on the asset allocation set by the Board of Trustees. In deciding the trade-off between risk and return, VRS can take advantage of the long time horizon of the pension financing plan. The long time horizon for investing means that as a general matter, VRS does not need to match pension liabilities with the short-term ups and downs in the market.

Benefits policy drives how much is paid to plan members

The General Assembly determines the benefits structure and plan design for pensions. Plan design influences cost--the more generous the benefits, the more costly the plan. The benefits for each plan are mostly determined when the plan opens, although benefits can also be changed throughout the life of the plan. However, when benefits are added costs are added.

Benefit improvements can be prospective or retroactive. When new benefits are prospective, or apply to future service credit only, there are opportunities to fund the benefit increases over the working lifetimes of affected employees. This policy promotes fairness across generations, or "intergenerational equity." The current generation pays for benefits for employees whose service occurs in the current generation.

When new benefits are retroactively granted based on past and future service, then intergenerational equity can be compromised. This is because the current generation

must pay not only for the benefits of their own generation, but also for the benefits of past generations.

Since 2010 the General Assembly has been actively involved in pension reforms in an effort to lower the risk and cost of benefits provided to VRS members. Exhibits 4 and 5 show the normal cost rates for the three benefit tiers within the State plan and the development of the blended employer rate. The new plan designs put forth have lowered the cost for employers, and with the introduction of the hybrid plan in 2014, which includes a defined contribution component, have also introduced a variety of new plan design elements including more shared risk with members.

Exhibit 4

	VRS State Retirement Plan			
	VRS Plan 1	VRS Plan 2	Hybrid	Blended Rate
Total Benefit Normal Cost	9.64%	8.95%	5.17%	9.10%
Member Contribution Rate	5.00%	5.00%	4.00%	4.92%
Employer Normal Cost Rate	4.64%	3.95%	1.17%	4.18%
Employer Match to DC Plan	0.0%	0.0%	1.21%	0.10%
Administrative Expense	0.27%	0.27%	0.27%	0.27%
Total Employer Rate without Unfunded Amortization Cost	4.91%	4.22%	2.65%	4.55%

The Teacher plan shows similar impacts in the plan normal cost as shown below.

Exhibit 5

	VRS Teacher Retirement Plan			
	VRS Plan 1	VRS Plan 2	Hybrid	Blended Rate
Total Benefit Normal Cost	11.23%	9.70%	5.68%	10.54%
Member Contribution Rate	5.00%	5.00%	4.00%	4.93%
Employer Normal Cost Rate	6.23%	4.70%	1.68%	5.61%
Employer Match to Hybrid DC Plan	0.0%	0.0%	1.21%	0.07%
Administrative Expense	0.25%	0.25%	0.25%	0.25%
Total Employer Rate without Unfunded Amortization Cost	6.48%	4.95%	3.14%	5.93%

Pension reform efforts for public employee retirement benefits in Virginia have mostly been applicable to future employees, which has had little impact on lowering the legacy unfunded liabilities of the current plans. Exhibits 6 and 7 show that nearly two-thirds of the cost to provide VRS benefits is to pay down unfunded legacy costs.

Exhibit 6

	VRS State Retirement Plan			
	VRS Plan 1	VRS Plan 2	Hybrid	Blended Rate
Total Benefit Normal Cost	9.64%	8.95%	5.17%	9.10%
Member Contribution Rate	5.00%	5.00%	4.00%	4.92%
Employer Normal Cost Rate	4.64%	3.95%	1.17%	4.18%
Employer Match to DC Plan	0.0%	0.0%	1.21%	0.10%
Administrative Expense	0.27%	0.27%	0.27%	0.27%
Total Employer Rate without Unfunded Amortization Cost	4.91%	4.22%	2.65%	4.55%
Amount to Amortize Unfunded Liability	8.94%	8.94%	8.94%	8.94%
Total Employer Rate	13.85%	13.16%	11.59%	13.49%

The employer costs associated with the Teacher plan show a similar results

Exhibit 7

	VRS Teacher Retirement Plan			
	VRS Plan 1	VRS Plan 2	Hybrid	Blended Rate
Total Benefit Normal Cost	11.23%	9.70%	5.68%	10.54%
Member Contribution Rate	5.00%	5.00%	4.00%	4.93%
Employer Normal Cost Rate	6.23%	4.70%	1.68%	5.61%
Employer Match to Hybrid DC Plan	0.0%	0.0%	1.21%	0.07%
Administrative Expense	0.25%	0.25%	0.25%	0.25%
Total Employer Rate without Unfunded Amortization Cost	6.48%	4.95%	3.14%	5.93%
Amount to Amortize Unfunded Liability	10.39%	10.39%	10.39%	10.39%
Total Employer Rate	16.87%	15.34%	13.53%	16.32%

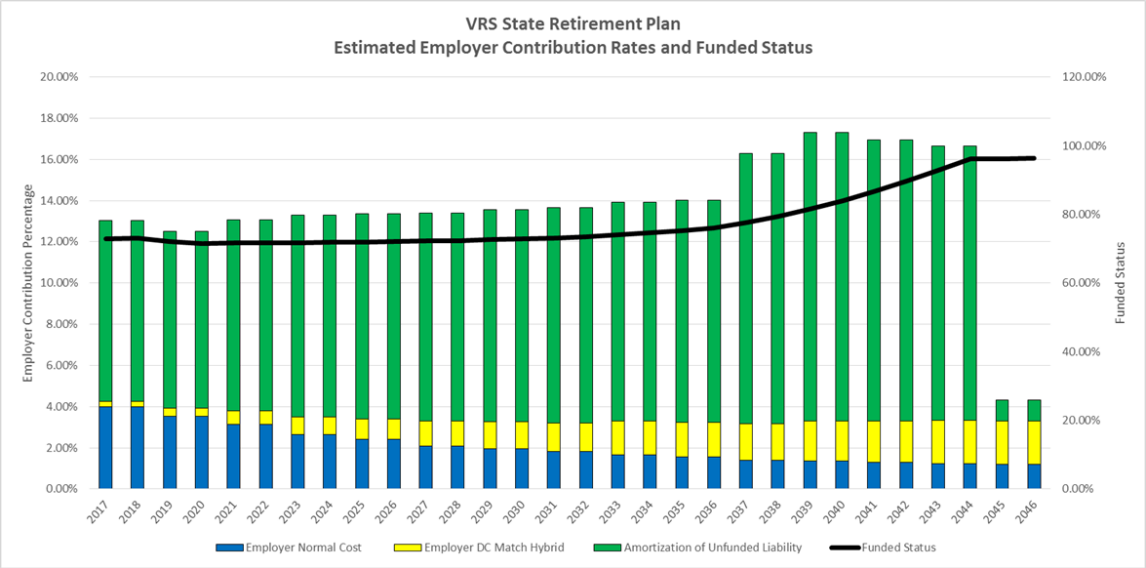
In contrast, when viewing the political subdivision plans in aggregate Exhibit 8 shows that only approximately one-third of the employer cost is associated with legacy costs. Despite many of the political subdivision plans containing richer benefits for enhanced hazardous duty personnel, the political subdivision plans have been able to maintain a more reasonable employer cost due to regularly funding the full required plan contribution.

Exhibit 8

	Political Subdivisions in Aggregate			
	VRS Plan 1 Members	VRS Plan 2 Members	Hybrid Members	Blended Rate for All Employees
Total Benefit Normal Cost	11.96%	11.11%	5.02%	11.23%
Member Contribution Rate	5.00%	5.00%	4.00%	4.93%
Employer Normal Cost Rate	6.96%	6.11%	1.02%	6.30%
Employer Match to Hybrid DC Plan	0.0%	0.0%	1.21%	0.09%
Administrative Expense	0.23%	0.23%	0.23%	0.23%
Total Employer Rate without Unfunded Amortization Cost	7.19%	6.34%	2.46%	6.62%
Amount to Amortize Unfunded Liability	3.41%	3.41%	3.41%	3.41%
Total Employer Rate	10.60%	9.75%	5.87%	10.03%

If we project out future rates for the State plan under current plan assumptions, Exhibit 9 shows that contribution rates are expected to remain around the 14% of covered payroll level until the legacy unfunded liability is paid off in 2044, at which time employer rates are expected to show a significant drop.

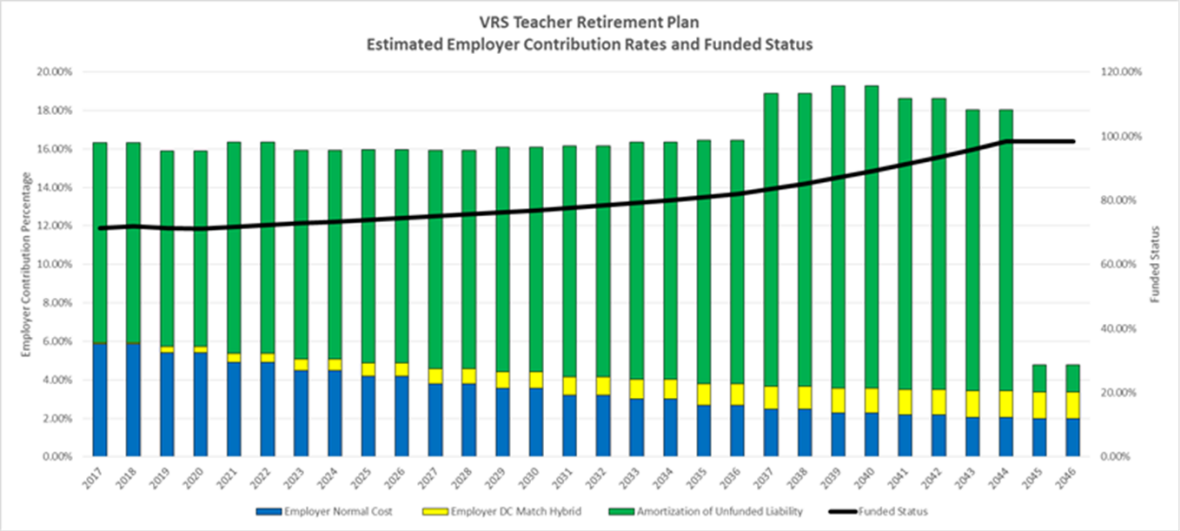
Exhibit 9



The Teacher plan is expected to have a similar pattern where the employer contribution rates expected to remain just above 16% of covered payroll under current forecast until the legacy liability is paid off.

Exhibit 10

PENSION FUNDING BASICS



Both public and private pension plans have rules that prevent employers from arbitrarily reducing employees' pension benefits. In the private sector, the rule is known as the ''anti-cutback rule" and derives from federal legislation known as the Employee Retirement Income Security Act (ERISA). In the public sector similar protections are found in state and local laws, state constitutions, and/or case law.

In Virginia, pension benefits are usually treated like contractual rights. This means that employees generally expect employers to pay pension benefits at the time of retirement according to the plan or plans that covered them during their public employment when they became vested.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

There are several indicators to consider as we evaluate the current health of Virginia's pension plans. One popular measure, “funded status," indicates the relationship between assets and liabilities at a single point in time. If the funded status is 100 percent, then there is one dollar in actuarial assets for each dollar of accrued liability (earned benefits). Exhibit 11 shows the funded status for each state-wide plan and political subdivisions in aggregate as of June 30, 2016. Traditionally, a healthy plan’s funded status would generally be in excess of 80%, although a plan with a funded status of less than 80% should not necessarily be considered to be in trouble. Generally auditors and bond rating agencies are looking to see that plan sponsors have a clear funding policy that lays out a plan to fully fund pension benefits within a reasonable time period and that they are sticking to the plan.

Exhibit 11

(Dollars in Thousands)	State	Teachers	SPORS	VaLORS	JRS	Political Subdivisions in Aggregate	Total VRS Pensions
Accrued Liability	$22,878,243	$43,581,629	$1,081,980	$1,984,257	$607,798	$20,659,120	$90,793,027
Valuation Assets	$16,672,776	$30,768,277	$744,656	$1,235,490	$476,321	$17,762,683	$67,660,203
Unfunded Liability	$6,205,467	$12,813,352	$337,324	$748,767	$131,477	$2,896,437	$23,132,824
Funded Ratio	72.9%	70.6%	68.8%	62.3%	78.4%	86.0%	74.5%

Another popular indicator of plan health, which also corresponds to the funded status, is the amount of the unfunded past liabilities for benefits already earned. We refer to these liabilities as “legacy costs”. They are also known as Unfunded Actuarial Accrued Liabilities or UAAL. As of June 30, 2016 the unfunded liability of all VRS-administered pension plans was $23.1 billion using the actuarial value of assets.

To understand the circumstances that can impact the financial health of a retirement plan, we looked back over the last twenty-five years, the period from 1992 to 2016, to help provide insight. It is helpful to see how investments, funding policy, and benefit improvements were affecting assets and liabilities over the last twenty-five years. Why twenty-five years? This period corresponds to the last time the General Assembly fully funded the recommended contribution rates for the state-wide systems prior to fiscal year 2017.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

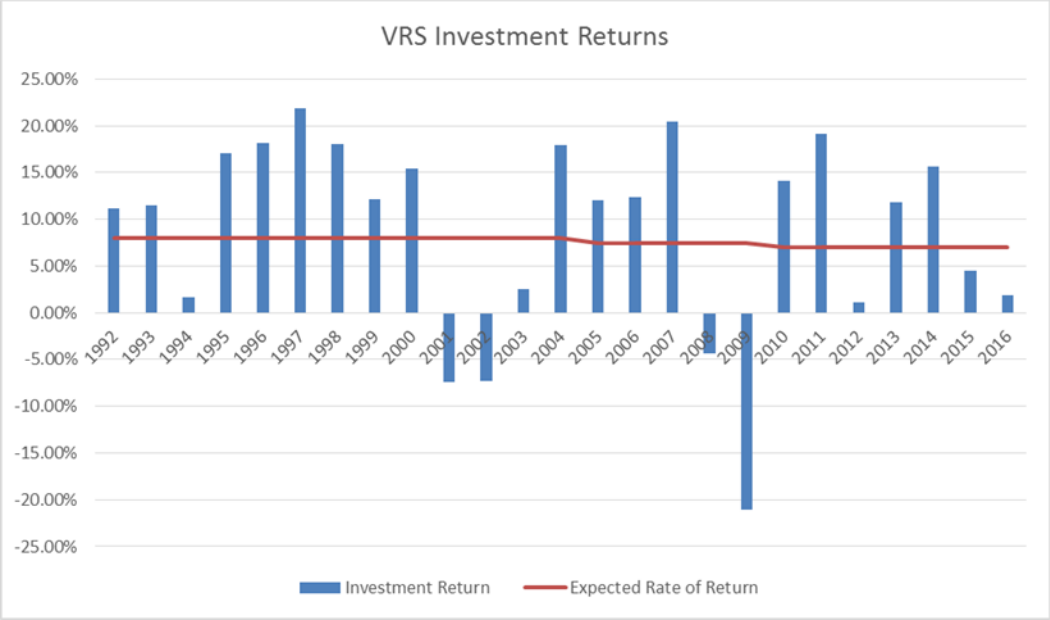
Investment income

As mentioned in the discussion of pension basics, the current long-term financing plan for pensions relies on achieving a target rate of return on investments over time. Returns need to hit or exceed the long-term rate of return assumption, currently 7.0 percent per year, over time for the financing plan for pensions to work as intended.

Recent market volatility has caused many to believe that investment losses have been the primary reason for the drop in retirement plan funded status. In reality, the two major causes for the drop in funded status for VRS plans have been perennial underfunding of recommended contributions, along with the adjustments to long-term rates of return brought on by major changes in market outlooks due to the market crisis in 2008-2009.

Exhibit 12 shows the annual investment rate of return from the VRS Trust Fund by fiscal year. Prior to 2005, the target rate of return was 8.0%. In 2005 the return was lowered to 7.5%, and in 2010 the target return was lowered to 7.0%. Over the twenty-five year period, the fund has returned an average annual return of 8.28 percent, exceeding the assumed rate of return assumption for that period.

Exhibit 12



HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

VRS was one of handful of plans to move to a more conservative assumed rate of return in 2010. In recent years many systems are now following our lead and lowering long term expected rates of return for their plans. As noted earlier, the average rate of return assumption for the 127 public plans surveyed by NASRA was still 7.52% as of February 1, 2017.

Taking a closer look at what has transpired since 1993, unfunded contributions and lost interest earnings on those contributions account for approximately 44% of the State plan UAAL, while reductions in the plan funding rate from 8.0% to 7.0% account for nearly 40% UAAL. The remaining 16% is associated with unexpected plan experience, which would include investment earnings, benefit enhancements, purchase of prior service, work force transition benefits (WTA), and negative amortization of UAAL. Negative amortization is an increase in the unfunded liability caused by making payments that fail to cover the interest due. This can be caused by either setting amortizations over long periods or by using open or rolling amortization methods to pay down unfunded liabilities.

Exhibit 13

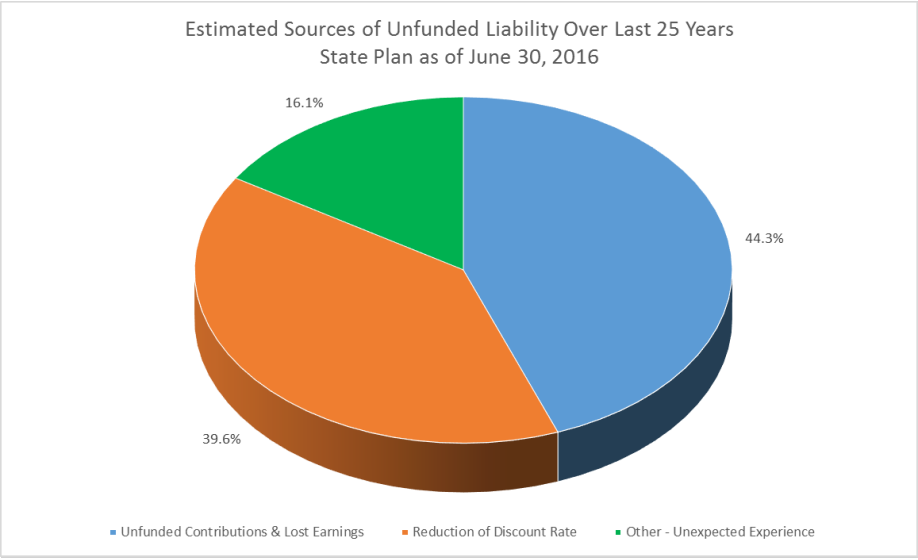


Exhibit 14 shows that the State and Teacher plans allocation of the UAAL are very similar while the political subdivisions, which have consistently contributed the full actuarial certified contribution, have a much lower UAAL.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

Exhibit 14

Unfunded Liability as of June 30, 2016

($Billions)

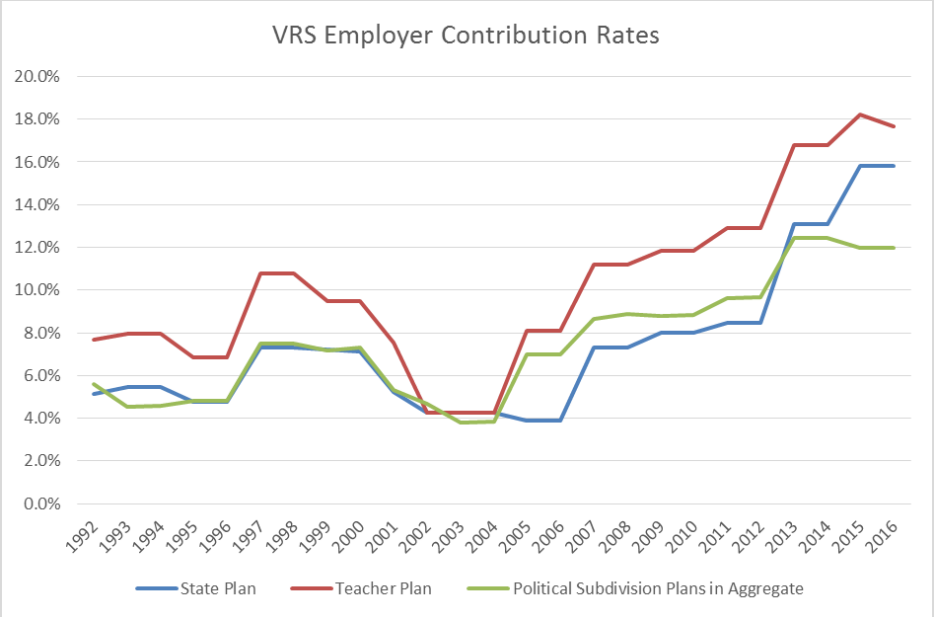
	State	Teachers	Political Subdivisions - Aggregate
Total Unfunded Liability	$6.51	$13.41	$3.26
Unfunded Due to Change in Discount Rates	$2.24	$4.80	$2.18
Unfunded Due to Underfunding & Lost Interest on Contributions	$3.51	$7.02	$0.26
Unfunded Due to Plan Experience including Investments	$0.76	$1.59	$0.82

It is important to note that in VRS-administered plans, employees do not pay pension contributions for legacy costs. Legacy costs are spread among employers. VRS regularly collects these payments from employers as a percentage of employee pay.

Today, required contribution rates are higher than they have ever been due in part to the legacy unfunded charge that is required to pay down those costs. Exhibit 15 below compares the employer contribution rates for the State, Teacher, and Political Subdivision plans in aggregate. It is worth noting that the political subdivision plans also include the cost of benefits for hazardous duty members, which are more expensive than those provided to general State and Teacher employees, yet their employer costs are generally less than State and Teacher employers because overall they have less unfunded liability.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

Exhibit 15

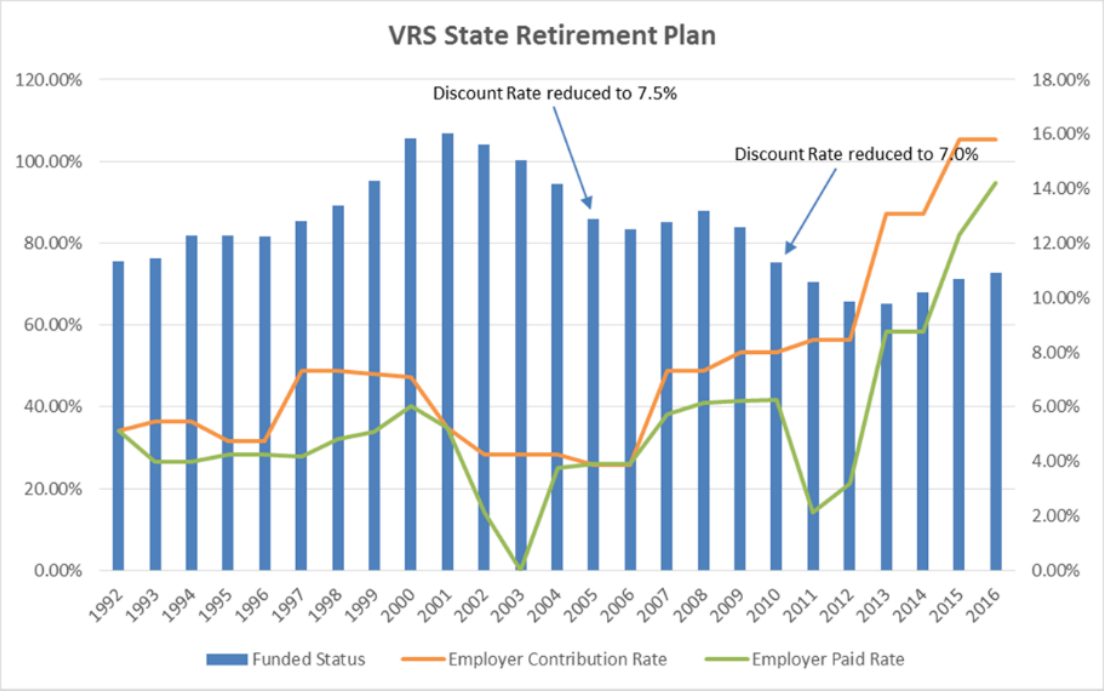


Underfunding decreases pension income

NASRA noted in a 2015 report that State plans on average were receiving about 84% percent of the required contributions for the period 2001-2013. The VRS State plan received approximately 67% of the required contribution over this period. As we mentioned earlier, the full actuarially determined contribution for the VRS State plan has only been funded three times since 1992, with the average amount contributed over the last 25 years was approximately 71% of what was required. Exhibit 16 shows the contribution activity for the State plan over the last 25 years as well as the corresponding historical funded status.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

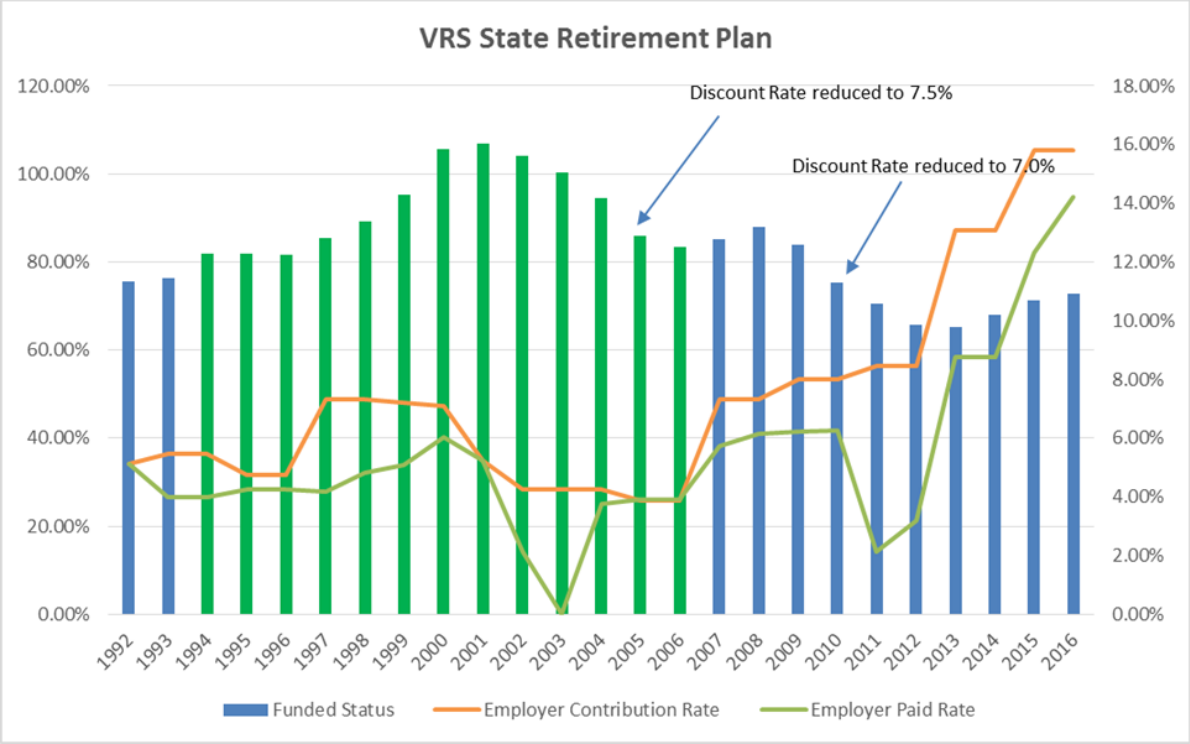
Exhibit 16



The increase in the funded status from 1994 to 2001 was driven almost entirely by the average market returns of 14.4% each year when the expectation was an 8.0% return. Even with contributions less than required, robust investment returns masked their negative impact. From 2001 through 2003 the market returned an average of -4.1%, which in combination with lower than expected contributions caused funding to decrease. In addition to the lower returns, benefit enhancements such as an increased benefit multiplier and the introduction of the 50/30 retirement were added to the plan benefits, which increased plan liabilities.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

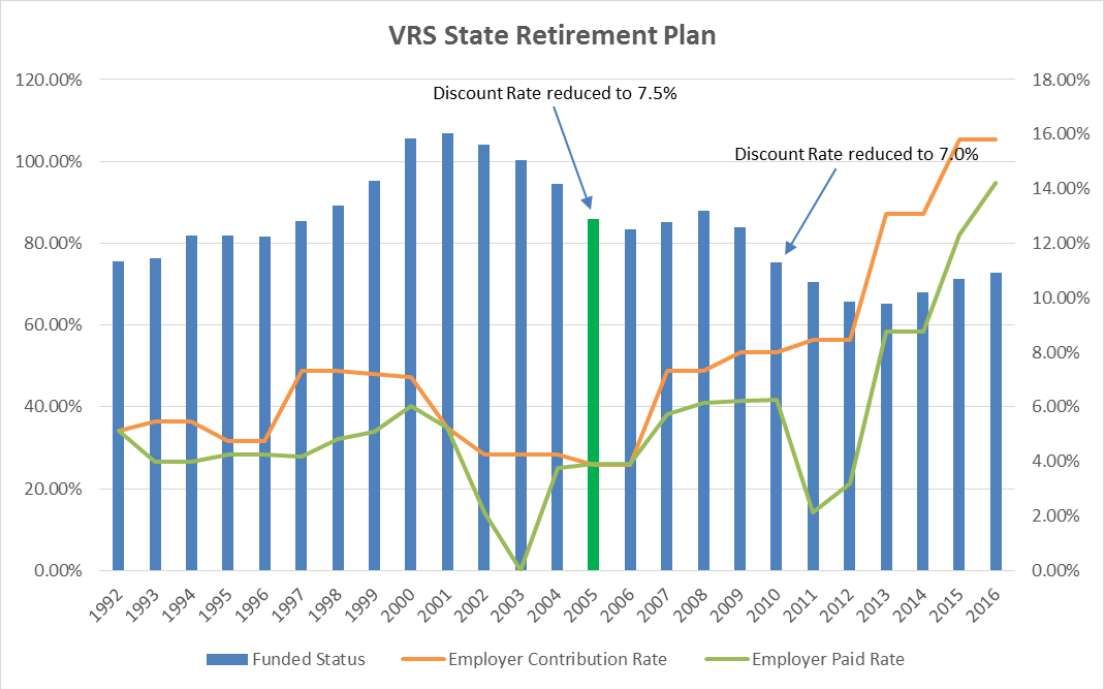
Exhibit 17



In 2005 market indicators and long-term economic forecasts suggested that the long-term 8.0% return was probably not attainable without taking on additional risk. This prompted the VRS Board of Trustees to reduce the long-term rate of return assumption to 7.5%. 2007 was the first fiscal year in which the contribution requirements were based on the new 7.5% discount rate. The General Assembly continued to fund the plan using alternative assumptions which included the prior 8.0% discount rate.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

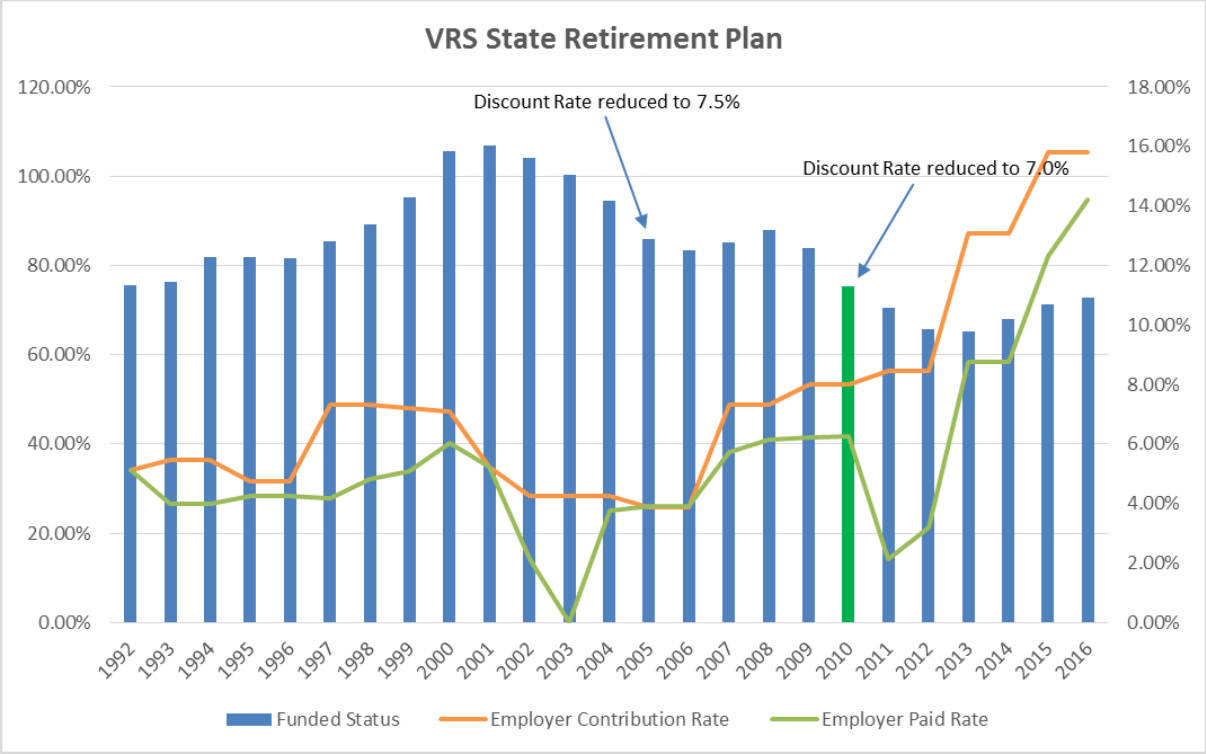
Exhibit 18



In 2010, shortly after the 2009 economic crisis, the VRS Board of Trustees again lowered the long-term rate of return assumption, this time to 7.0%. The General Assembly continued to base funding on an alternative set of assumptions, which included an 8.0% rate of return. By 2011, the amount being funded by the General Assembly was only 65% of the VRS Board certified actuarially determined contribution rate. Underfunding and recognition of the 2009 market losses continued to drive the funding status lower. In addition, in 2010 additional unfunded liability was added to the fund through the use of the Work Force Transition benefits (WTA) for terminated members without any corresponding payment by the applicable employers to VRS to pay for these enhanced benefits as the Commonwealth struggled with the State budget following the economic crisis.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

Exhibit 19



During the 2010 legislative session, the General Assembly began undertaking a series of pension reform initiatives by modifying the benefits for new employees, and introducing a new tier of benefits, Plan 2, for those hired on or after July 1, 2010. In succeeding legislative sessions, pension reform continued to be a hot topic and in 2012 another tier of benefits was added through the addition of a Hybrid retirement plan for those hired after January 1, 2014. The 2012 pension reforms also included a transition plan to move to 100% funding of the VRS Board Certified rates over the next six years.

The VRS Board established a new funding policy in 2013, which included moving to "closed" amortization of unfunded liabilities, facilitating paying off unfunded liabilities over set periods of time rather than using "rolling" amortizations.

The General Assembly also made additional contributions to State and Teacher plans to pay down the ten-year deferred contributions incurred in the 2010-2012 biennium and also accelerated the transition funding schedule for State plans. Exhibit 20 shows that

these changes along with pension design changes have had a positive effect on the plan funded status.

Exhibit 20

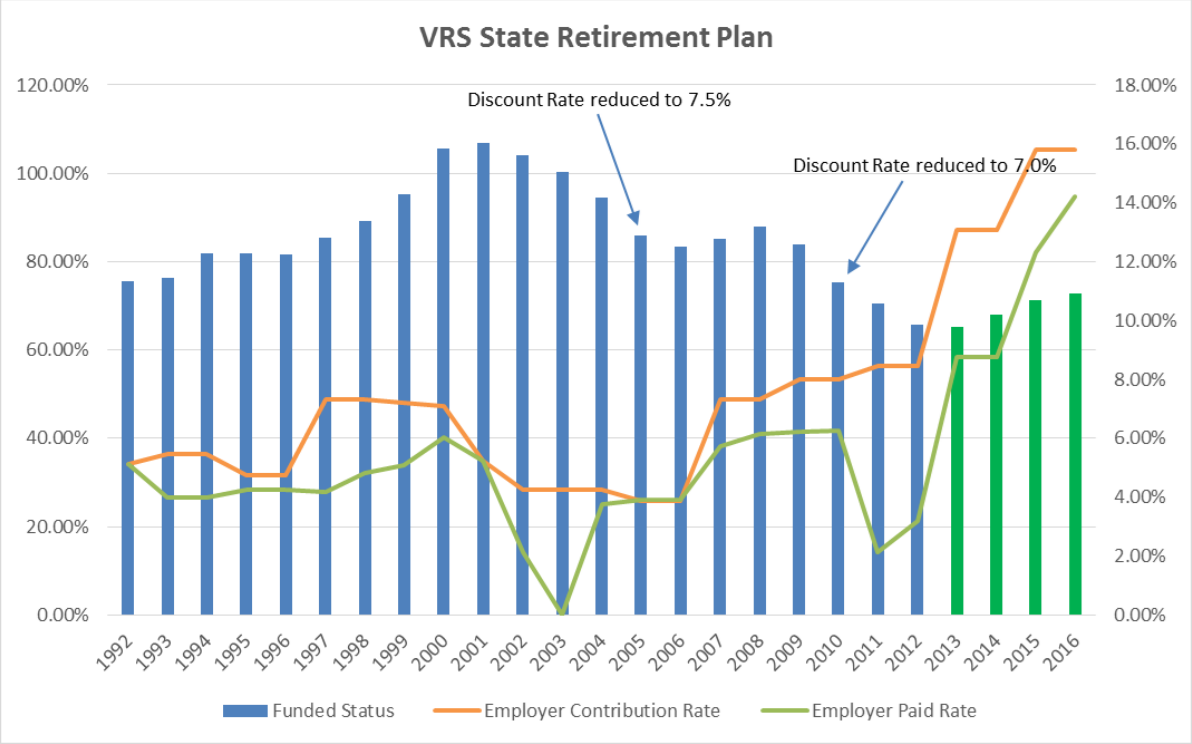
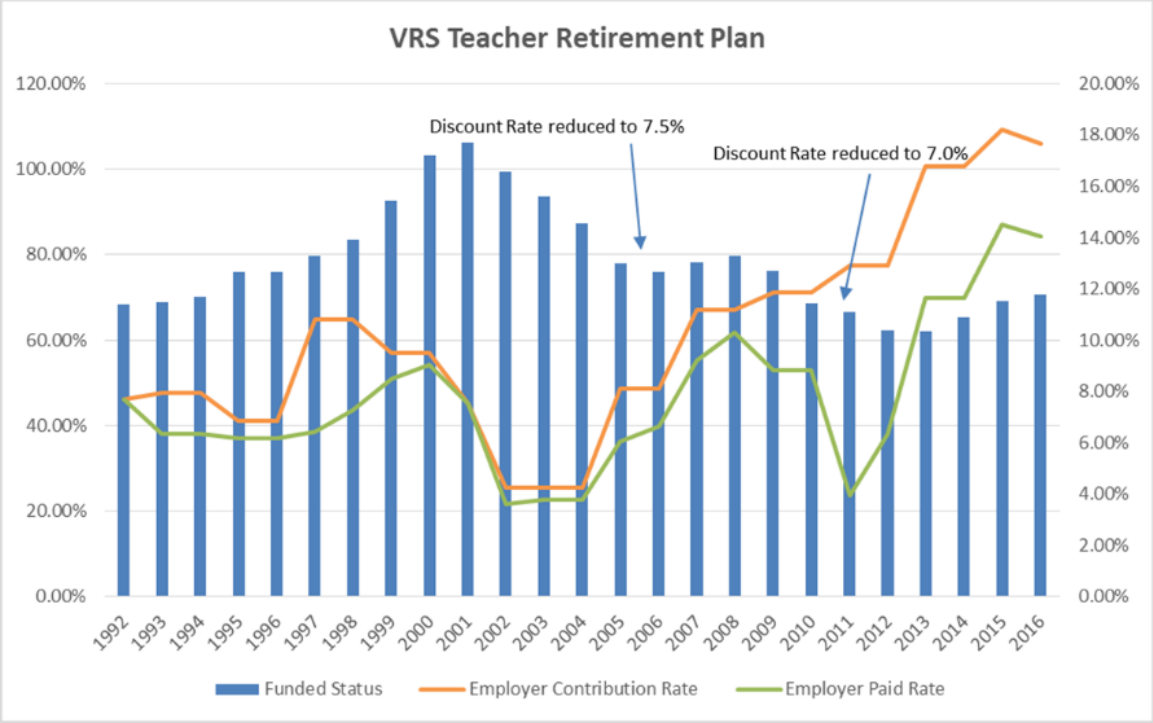


Exhibit 21 shows a very similar pattern with the Teacher plan. Since 1992 the actuarially determined contribution for the Teacher plan has only been funded once. On average the Teacher plan received approximately 77% of the required contributions.

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

Exhibit 21

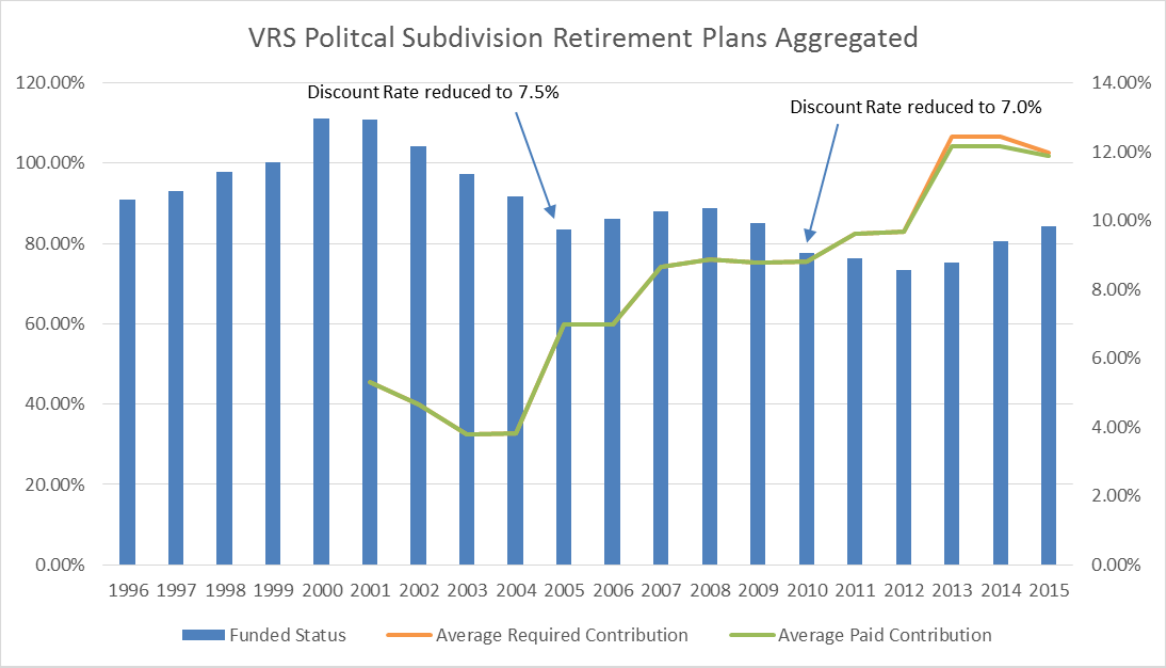


Conversely, Exhibit 22 shows that during this same period the political subdivisions plans averaged receiving approximately 98% of their required contributions. Note that by statute, political subdivisions are generally required to fund 100% of the required contribution. However the 2012 Appropriation Act provided localities the option to choose the full certified rate or a lower alternative rate to help cope with revenue shortfalls during that period, 90% of the plans chose the certified rate.

So even though they also saw reductions in plan funded status, the political subdivisions plans were able to make a much quicker recovery because most funded the full required contributions .

HISTORICAL REVIEW – TWENTY-FIVE YEAR LOOKBACK

Exhibit 22

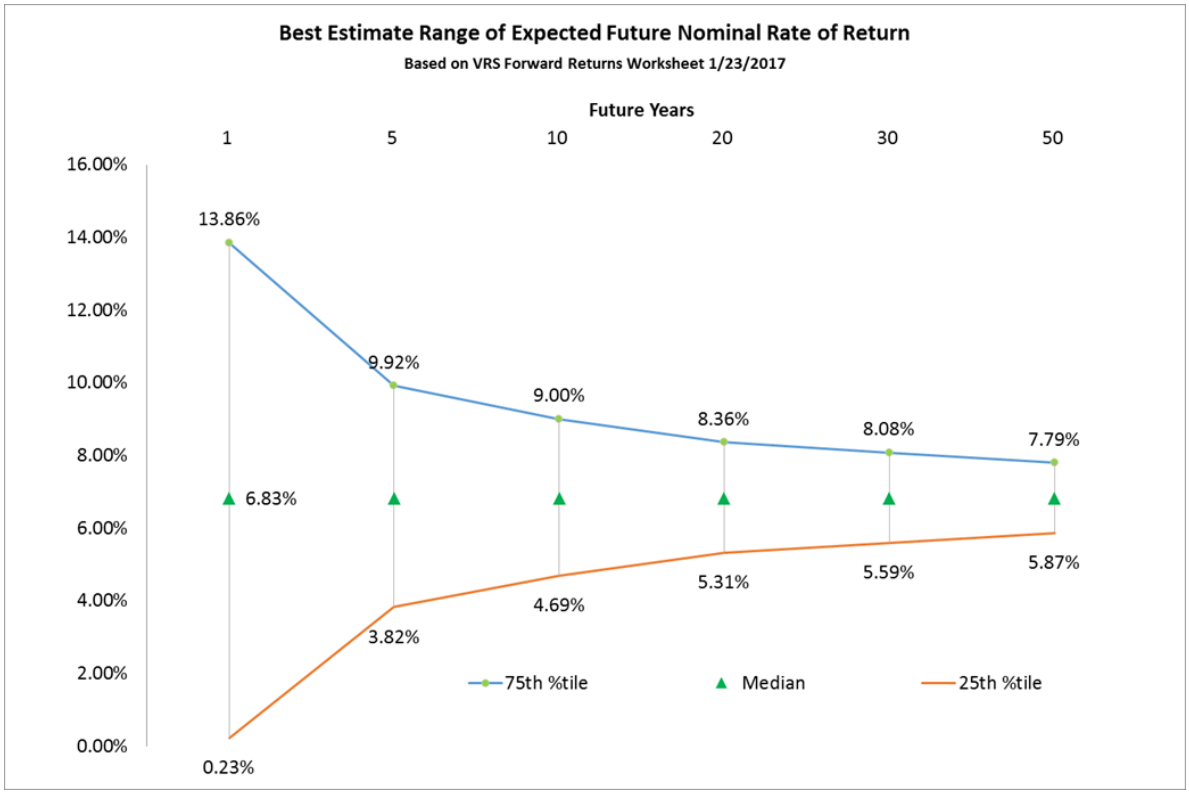


Analysis of Discount Rate Sensitivity

The discount rate reflects expectations of what the markets will deliver in the future and it is calculated based on two components: expected price inflation and real rate of return. A change in either of those components over the long term would necessitate further evaluation of the discount rate.

A recent review of the economic assumptions during the quadrennial experience study for the actuarial valuations included a statistical analysis of the reasonable range for the plan's assumed investment rate of return. Using the plan's 2.5% assumed rate of inflation and the 10-year forward looking capital market estimates and policy investment target provided by the VRS investment staff, the plan actuary computed an expected median nominal rate of return of 6.83%, with a reasonable range of 5.87% - 7.79%, representing the 25th and 75th percentiles, respectively.

Exhibit 23



FUTURE RISK ANALYSIS

Analysis of discount rate sensitivity on employer contribution rates gives a sense of the long-term risk to the employer contribution rates and changes to the funded status. The analysis provides the impact on employer contribution rates assuming discount rates that are up to two percentage points above or below the current valuation discount rate. This analysis gives an indication of the potential required employer contribution rates if the discount rate ranged from 5.0 percent or 9.0 percent over the long-term. GASB 67 currently requires sensitivity analysis of plus or minus 1% from the plan's discount rate. Adding a wider range of plus or minus 2% around the plan discount rate resulted from discussions during deliberations of the Commission on Employee Retirement Security and Pension Reform.

Exhibit 24 illustrates how the assumed annual rate of return would affect pension contribution rates for the State plan. A lower assumed annual rate of return requires higher contribution rates from employers. Although the assumed rate of return dictates how contribution rates are calculated in the short-term, the actual investment returns will determine how much of pension costs must be covered by contributions in the long-term.

Exhibit 24 – State Plan

Discount Rate	9.00%	8.00%	Current 7.00%	6.00%	5.00%
Total Normal Cost Rate	6.43%	7.67%	9.30%	11.50%	14.49%
Member Contribution Rate	4.69%	4.69%	4.69%	4.69%	4.69%
Employer Normal Cost Rate	1.74%	2.98%	4.61%	6.81%	9.80%
Administrative Expense Load	0.26%	0.26%	0.26%	0.26%	0.26%
Total Employer Normal Cost Rate	2.00%	3.24%	4.87%	7.07%	10.06%
Amortization Rates for Unfunded Liabilities					
Legacy Unfunded	13.25%	12.04%	10.88%	9.76%	8.70%
2014 Gain	-0.91%	-0.85%	-0.79%	-0.73%	-0.67%
2015 Gain	-1.36%	-1.27%	-1.17%	-1.08%	-1.00%
2016 Gain	-0.18%	-0.17%	-0.16%	-0.14%	-0.13%
Experience Study	0.13%	0.12%	0.11%	0.10%	0.10%
Change in Discount Rate	-8.88%	-4.45%	0.00%	4.51%	9.09%
Payback Rate	0.00%	0.00%	0.00%	0.00%	0.00%
Total Amortization Rate	2.05%	5.42%	8.87%	12.42%	16.09%
Total Employer Rate	4.05%	8.66%	13.74%	19.49%	26.15%
Increase Rate	-9.69%	-5.08%	0.00%	5.75%	12.41%
Estimated Increase in Annual Funding	(387.8) Million	(203.3) Million		230.1 Million	496.7 Million
General Fund	(165.7)	(86.9)		98.3	212.2
Non-General Fund	(222.1)	(116.4)		131.8	284.5
Unfunded Liability	$2.0 Billion	$4.0 Billion	$6.3 Billion	$9.0 Billion	$12.3 Billion
Funded Status	89.2%	80.8%	72.7%	64.9%	57.5%

Exhibit 25 – Teacher Plan

Discount Rate	9.00%	8.00%	Current 7.00%	6.00%	5.00%
Total Normal Cost Rate	7.09%	8.74%	10.95%	14.00%	18.17%
Member Contribution Rate	4.77%	4.77%	4.77%	4.77%	4.77%
Employer Normal Cost Rate	2.32%	3.97%	6.18%	9.23%	13.40%
Administrative Expense Load	0.25%	0.25%	0.25%	0.25%	0.25%
Total Employer Normal Cost Rate	2.57%	4.22%	6.43%	9.48%	13.65%
Amortization Rates for Unfunded Liabilities					
Legacy Unfunded	14.09%	12.80%	11.55%	10.37%	9.25%
2014 Gain	-1.09%	-1.02%	-0.95%	-0.88%	-0.81%
2015 Gain	-1.16%	-1.08%	-1.00%	-0.92%	-0.85%
2016 Gain	-0.45%	-0.42%	-0.38%	-0.35%	-0.32%
Experience Study	0.07%	0.07%	0.06%	0.06%	0.05%
Change in Discount Rate	-9.70%	-4.90%	0.00%	5.04%	10.25%
Payback Rate	0.85%	0.83%	0.82%	0.80%	0.78%
Total Amortization Rate	2.61%	6.28%	10.10%	14.12%	18.35%
Total Employer Rate	5.18%	10.50%	16.53%	23.60%	32.00%
Increase in Rate	-11.35%	-6.03%	0.00%	7.07%	15.47%
Estimated Increase in Annual Funding	($870.2) Million	($462.4) Million		$542 Million	$1,186 Million
General Fund	(348.1)	(185.0)		216.8	474.4
Non-General Fund	(522.1)	(277.4)		325.2	711.6
Unfunded Liability	$4.0 Billion	$8.0 Billion	$12.9 Billion	$18.8 Billion	$25.9 Billion
Funded Status	88.5%	79.3%	70.5%	62.1%	54.3%

Public pension plans have historically estimated future benefit liabilities using a discount rate that is based on estimated future investment returns of fund assets. This approach has come under mounting criticism by financial economists and public policy groups. These groups argue that a rate based on investment return assumptions vastly understates pension liabilities. In their view, the rate should be based on low risk, or even risk-free, bond rates to reflect the risk of the payments to plan members.

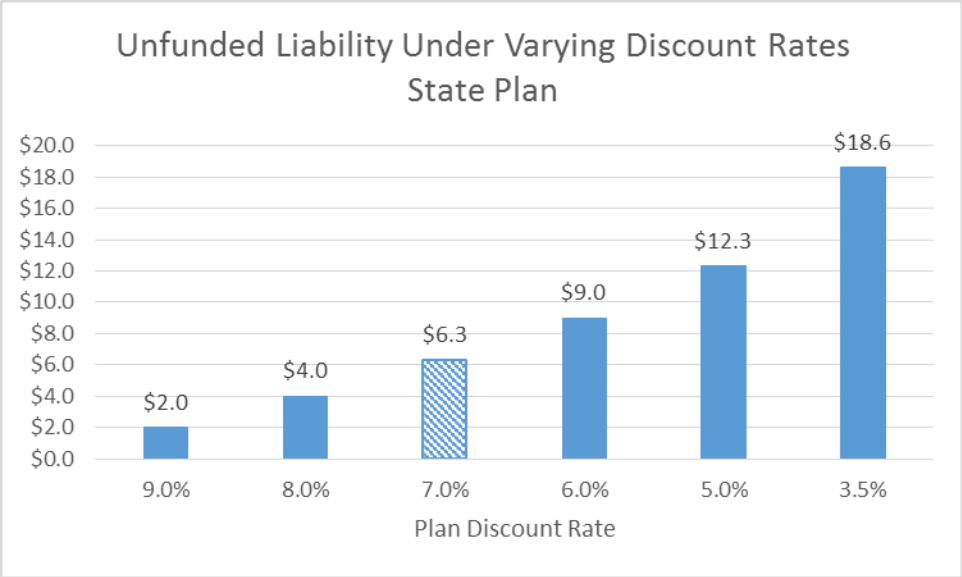
While a risk-free bond rate may not be the best rate to use as a funding requirement, it can be used to show the value of the benefit provided to members.

Using an estimated rate of return to discount future pension liabilities actually reflects the costs of funding pension benefits far better than using a risk-free or low-risk bond

rate of return. If appropriately set, the former will reflect an estimate that is much closer to the actual cost of pension benefits and therefore the liabilities of the system. In contrast, discounting these liabilities using a hypothetical bond rate reflects an estimate of the future value of these benefits to plan members, but would require employers to fund larger amounts which could create intergenerational inequities if funds were still invested in a diversified portfolio with expectations for a larger return on investments.

Employers and taxpayers should know the value of pension benefits received by public employees. But estimating this benefit amount does not reflect the actual costs of funding public pensions. Exhibit 26 shows the estimated unfunded liability of the State plan under different discount rate assumptions, including the estimated risk free rate of 3.5%.

Exhibit 26



Because of the nature of the plan liabilities, changes in discount rates are not always linear. With the 10-year economic forecasts suggesting lower expectations in the near term, the cost impacts of smaller changes in the discount rate of 25 and 50 basis points reductions are also included below.

Exhibit 27 – State Plan

Discount Rate	Discount Rate 7.00%	6.75%	6.50%
Total Normal Cost Rate	9.30%	9.79%	10.31%
Member Contribution Rate	4.69%	4.69%	4.69%
Employer Normal Cost Rate	4.61%	5.10%	5.62%
Administrative Expense Load	0.26%	0.26%	0.26%
Total Employer Normal Cost Rate	4.87%	5.36%	5.88%
Amortization Rates for Unfunded Liabilities			
Legacy Unfunded	10.88%	10.59%	10.31%
2014 Gain	-0.79%	-0.77%	-0.76%
2015 Gain	-1.17%	-1.15%	-1.13%
2016 Gain	-0.16%	-0.15%	-0.15%
Experience Study	0.11%	0.11%	0.11%
Change in Discount Rate	0.00%	1.12%	2.25%
Payback Rate	0.00%	0.00%	0.00%
Total Amortization Rate	8.87%	9.75%	10.63%
Total Employer Rate	13.74%	15.11%	16.51%
Increase Rate	0.00%	1.37%	2.77%
Estimated Increase in Annual Funding		54.8 Million	110.9 Million
General Fund		23.4	47.4
Non-General Fund		31.4	63.5
Unfunded Liability	$6.3 Billion	$6.9 Billion	$7.6 Billion
Funded Status	72.7%	70.7%	68.7%

Exhibit 28 – Teacher Plan

Discount Rate	Discount Rate 7.00%	6.75%	6.50%
Total Normal Cost Rate	10.95%	11.63%	12.36%
Member Contribution Rate	4.77%	4.77%	4.77%
Employer Normal Cost Rate	6.18%	6.86%	7.59%
Administrative Expense Load	0.25%	0.25%	0.25%
Total Employer Normal Cost Rate	6.43%	7.11%	7.84%
Amortization Rates for Unfunded Liabilities			
Legacy Unfunded	11.55%	11.25%	10.96%
2014 Gain	-0.95%	-0.93%	-0.91%
2015 Gain	-1.00%	-0.98%	-0.96%
2016 Gain	-0.38%	-0.38%	-0.37%
Experience Study	0.06%	0.06%	0.06%
Change in Discount Rate	0.00%	1.25%	2.49%
Payback Rate	0.82%	0.81%	0.81%
Total Amortization Rate	10.10%	11.08%	12.08%
Total Employer Rate	16.53%	18.19%	19.92%
Increase in Rate	0.00%	1.66%	3.39%
Estimated Increase in Annual Funding		127.2 Million	259.8 Million
General Fund		50.9	103.9
Non-General Fund		76.3	155.9
Unfunded Liability	$12.9 Billion	$14.2 Billion	$15.7 Billion
Funded Status	70.5%	68.4%	66.2%

Cash Flow Projections

Pension plans are designed to provide employees with a pension upon retirement. Contributions in VRS plans are generally shared by employees and their employer and are a systematic way of pre-funding the system's costs. The benefit of prefunding is that

investment return on the pre-funded plan assets reduces the employer's long-term contributions.

Retirement plans that have been in operation for a number of years generally have contributions coming into the plan and benefits being paid out. The net (non-investment) cash flow is the difference between the contributions and benefits and expenses of the fund. These cash flows will vary for each plan since all plans have different demographics and maturities.

Mature plans often have negative cash flows over time, which is considered the normal cycle of pension plans. Negative cash flows do not necessarily imply a plan is in trouble, in fact part of the benefit of pre-funding is so the investment return can pay a significant portion of the benefit payments.

Exhibit 29 below shows the projected contributions and investment return needed by the State plan to avoid negative cash flows over the next 30 years. Benefit payments in the State plan are expected to peak in 2039 before beginning to reduce as more members are covered by the Hybrid retirement plan. The investment return needed over this period to avoid negative cash flow ranges from 3.75% - 6.45% with an average return of approximately 4.9% to stay cash flow positive to the fund.

Exhibit 29

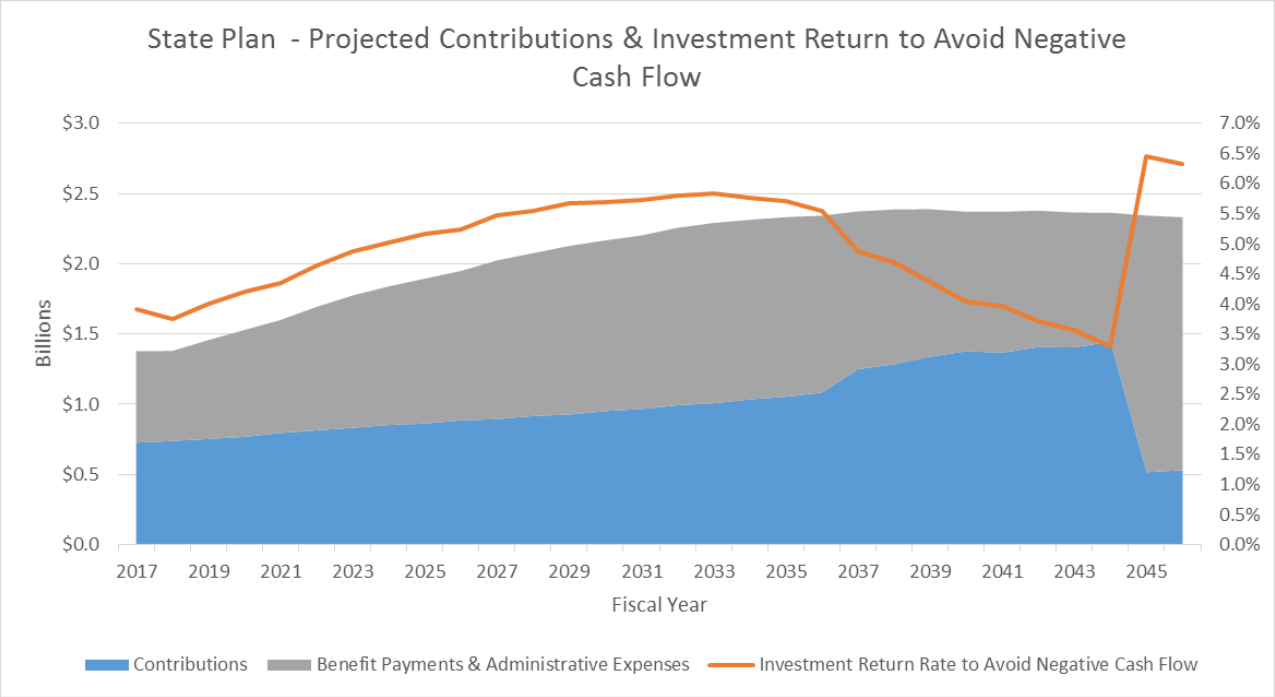
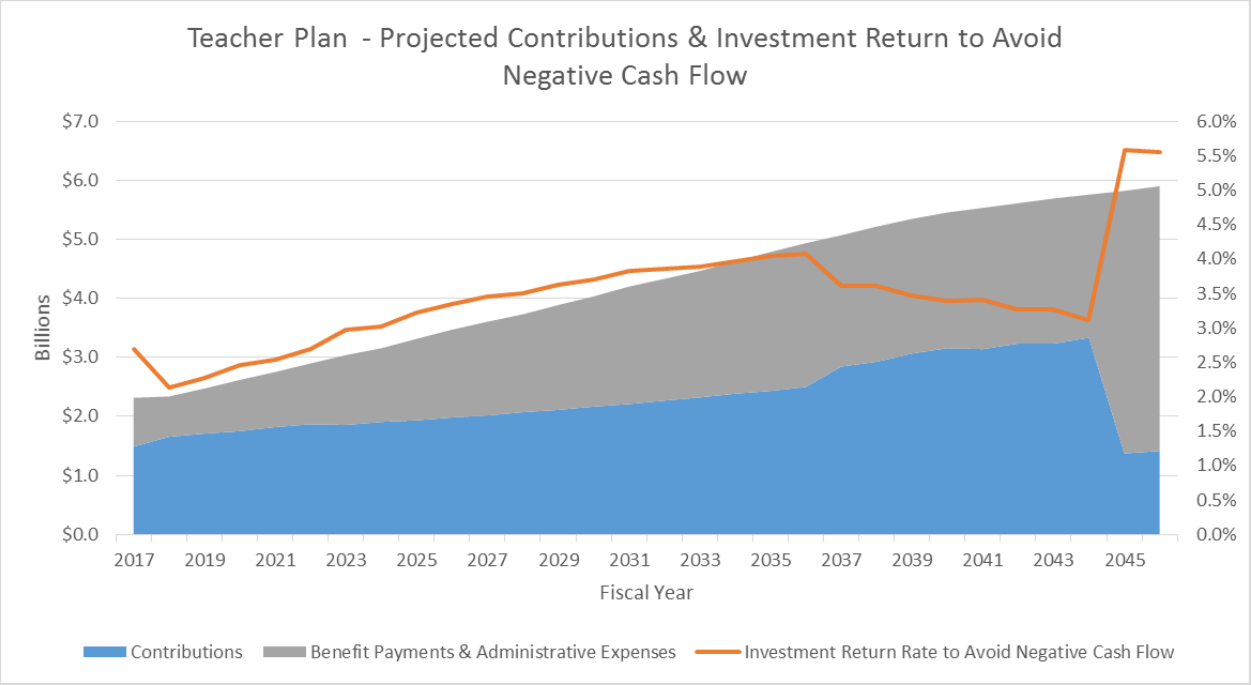


Exhibit 30 below shows the projected contributions and investment return needed by the Teacher plan to avoid negative cash flows over the next 30 years. Benefit payments in the Teacher plan are expected to peak beyond 2046 as turnover in this plan is less than seen in the State plan. The investment return needed over this period to avoid negative cash flow ranges from 2.13% - 5.58% with an average return of approximately 3.5% to stay cash flow positive to the fund.

Exhibit 30



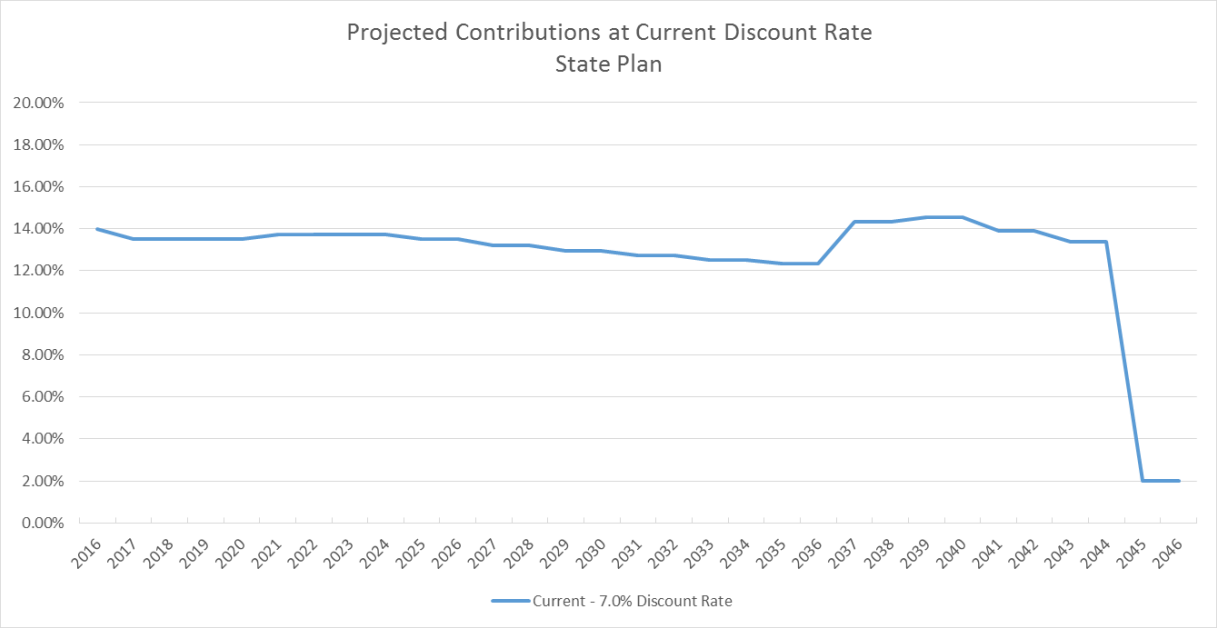
Possible Future Outcomes

Deterministic Projections

Projecting future outcomes can be done under two sets of analyses. Deterministic analysis assumes full certainty about future outcomes, particularly with future plan experience and assumptions including investment returns.

Exhibit 31 shows the expected future employer contribution rates for the State plan under a deterministic approach which assumes the plan achieves the assumed 7.0% return in all future years.

Exhibit 31



The deterministic approach is useful for gauging the general direction of change and associated consequences, and is useful when trying to assess best case or worst case scenarios, or isolating the impacts of a single assumption such as lowering the plan discount rate.

Exhibit 32 shows the impact on projected future contribution rates if the long term rate of return was lowered to 6.75% or 6.50%. The change increases the required contribution for the State plan by approximately $54.8 million per year if moving to 6.75% or $110.9 million per year if lowering the return expectation to 6.50%.

Exhibit 32

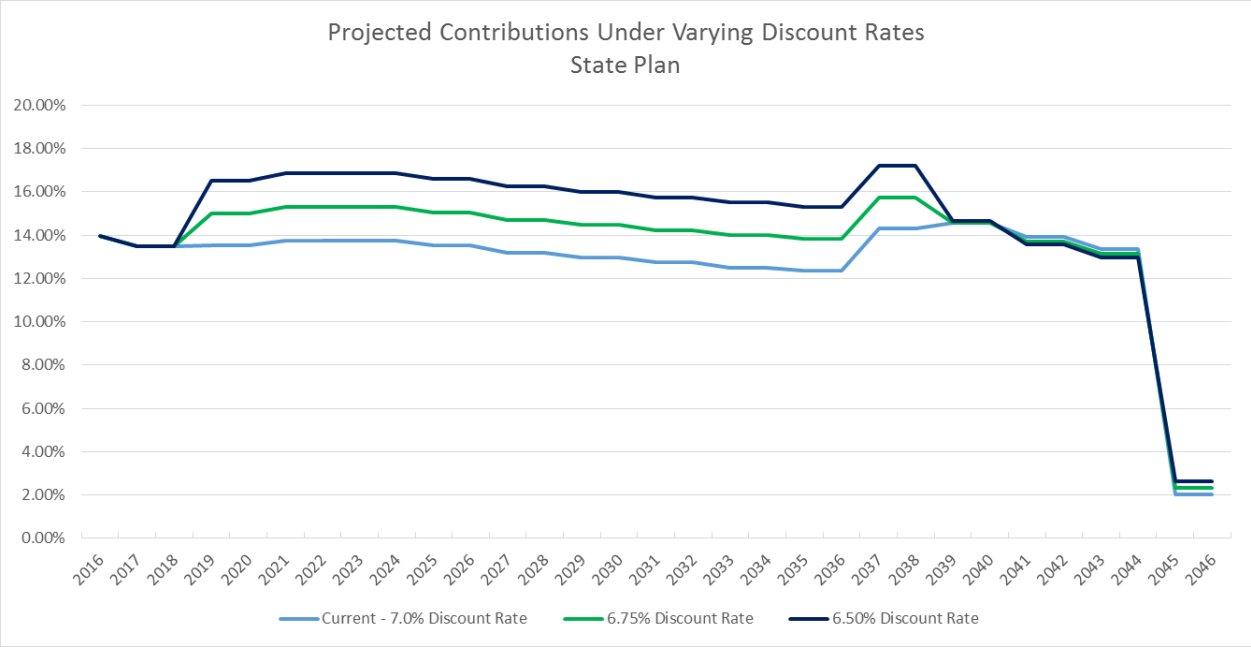
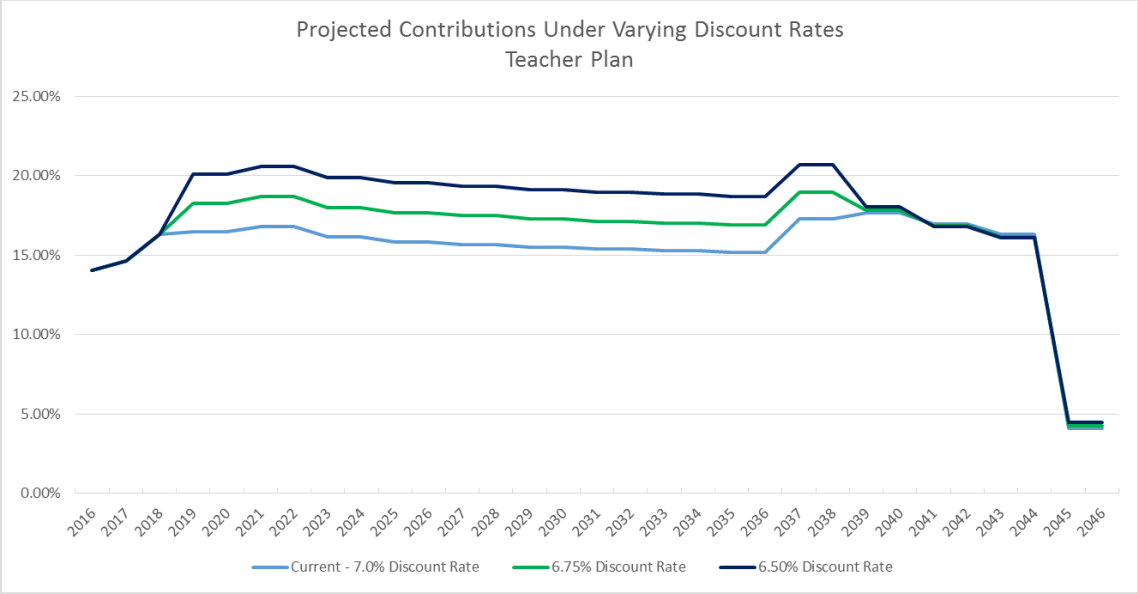


Exhibit 33 shows similar impacts on projected future contribution rates of the Teacher plan if the long term rate of return was lowered to 6.75% or 6.50%. The change increases the required contribution for the Teacher plan by approximately $127.2 million per year if moving to 6.75% or $259.8 million per year if lowering the return expectation to 6.50%.

Exhibit 33



Deterministic projections can also be used to show the impacts of future underfunding. Exhibit 34 shows the potential impact on future employer contributions rates if only 80% of actuarially determined contribution was made each year in the future. The exhibit shows that by paying only 80% of the required contribution, that overtime the employer rate will exceed the projection of the current rates funded at 100% and deteriorate the funded status.

Exhibit 34

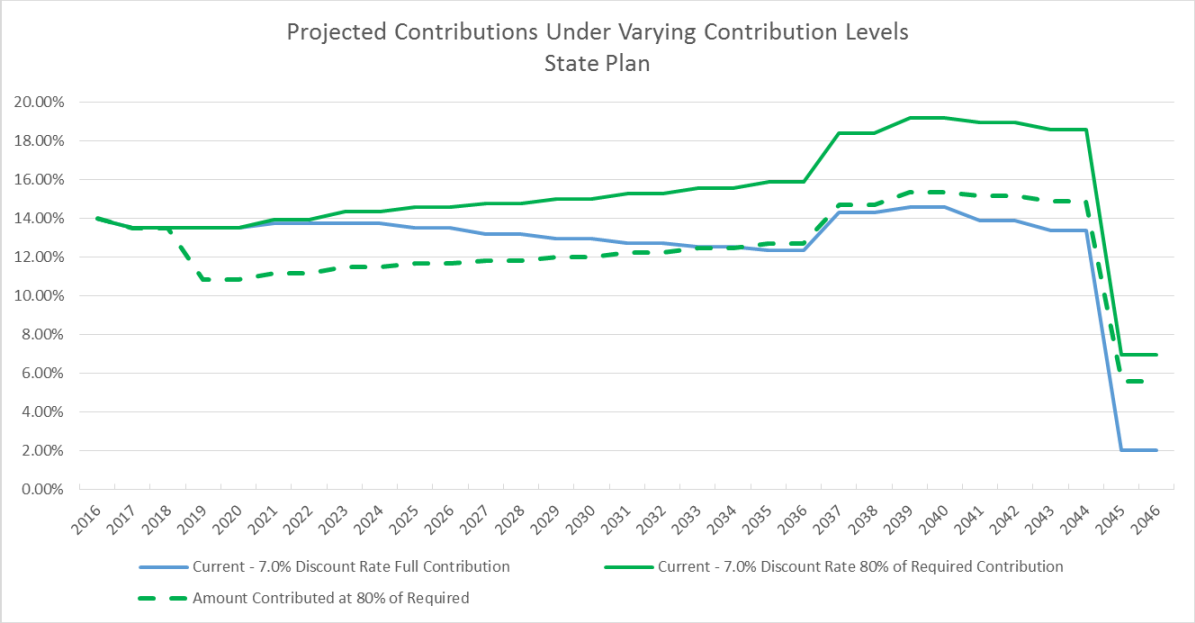
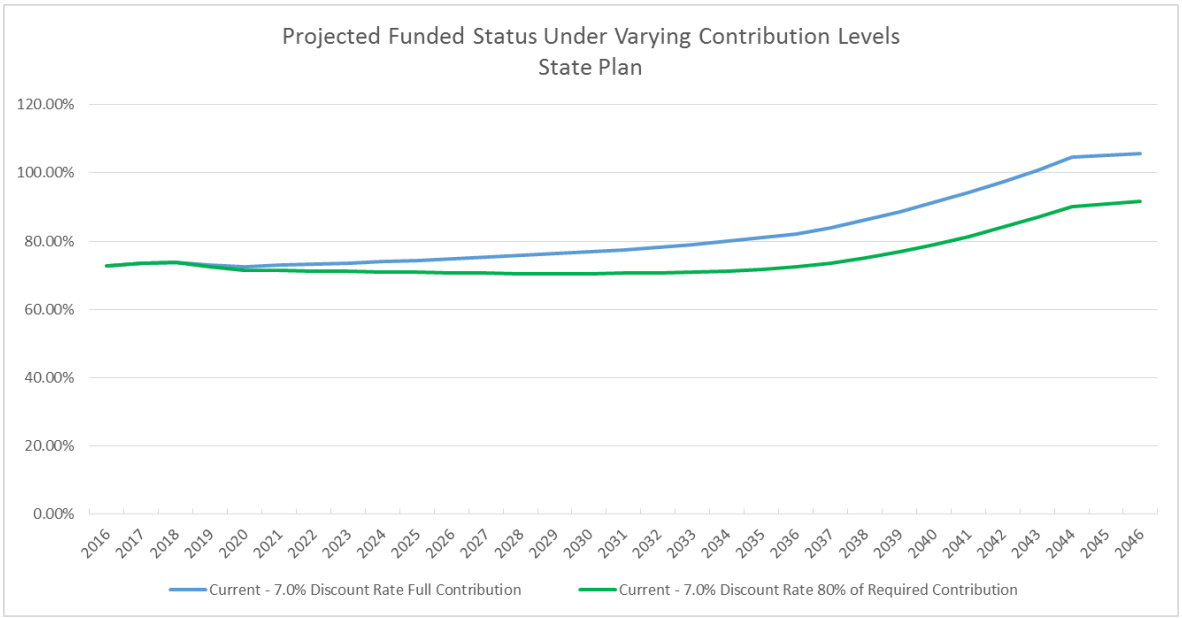


Exhibit 35 shows the corresponding impact on plan funded status under this scenario.

Exhibit 35



FUTURE RISK ANALYSIS

This analysis shows that underfunding causes an increase in future contribution rates and prohibits the plan from reaching full funding without investment returns above the assumed long term rate of return.

Deterministic projections can also be used to show the impacts of future investment returns on employer contributions and plan funded status. The economic events of 2008 and 2009 highlighted the investment risks associated with pension plan funding. During this period the plan experienced investment returns of -4.4% followed by a -21.1% return. Those losses caused the State plan assets to go from $15.9 billion in 2007 to $11.3 billion in 2009. It took five years for the fund to return to the 2007 levels as the fund was $16.1 billion in 2014.

Due to the smoothing of funding assets, the full impact of investment gains or losses are phased-in over a five year period to help moderate investment volatility as required by Code. Section 51.1-145. In addition, changes in unfunded liability are amortized over 20 year closed periods again in an effort to moderate employer rates to allow time to budget for changes in retirement costs.

When reviewing investment impacts it is also important to note that the timing of an investment loss will affect the impact on funding. The State plan's funded status as of June 2016 was approximately 72%. The impact of a negative 10% return today would have more severe consequences than if the negative 10% return occurred 20 years from now. This is due to the fact that the State plan currently has an unfunded liability that makes up approximately two-thirds of the plan's contribution rate. Taking on another large unfunded liability prior to the legacy unfunded liability being paid off would cause rates to increase more sharply and for a longer period of time.

Exhibit 36

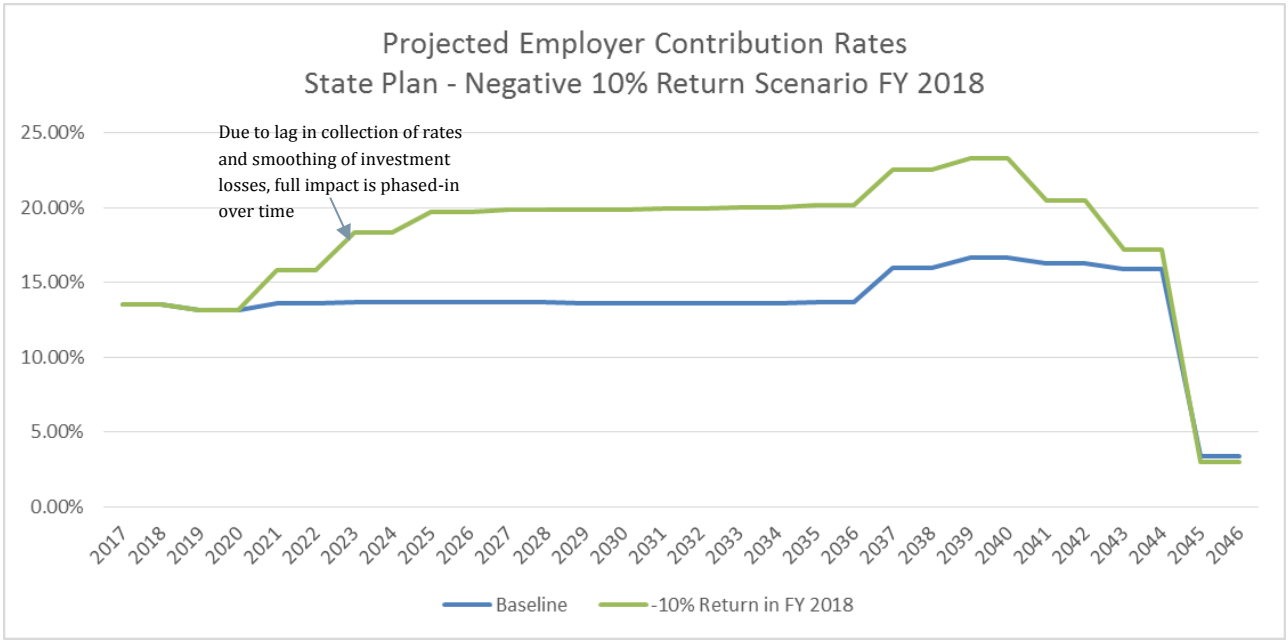


Exhibit 37

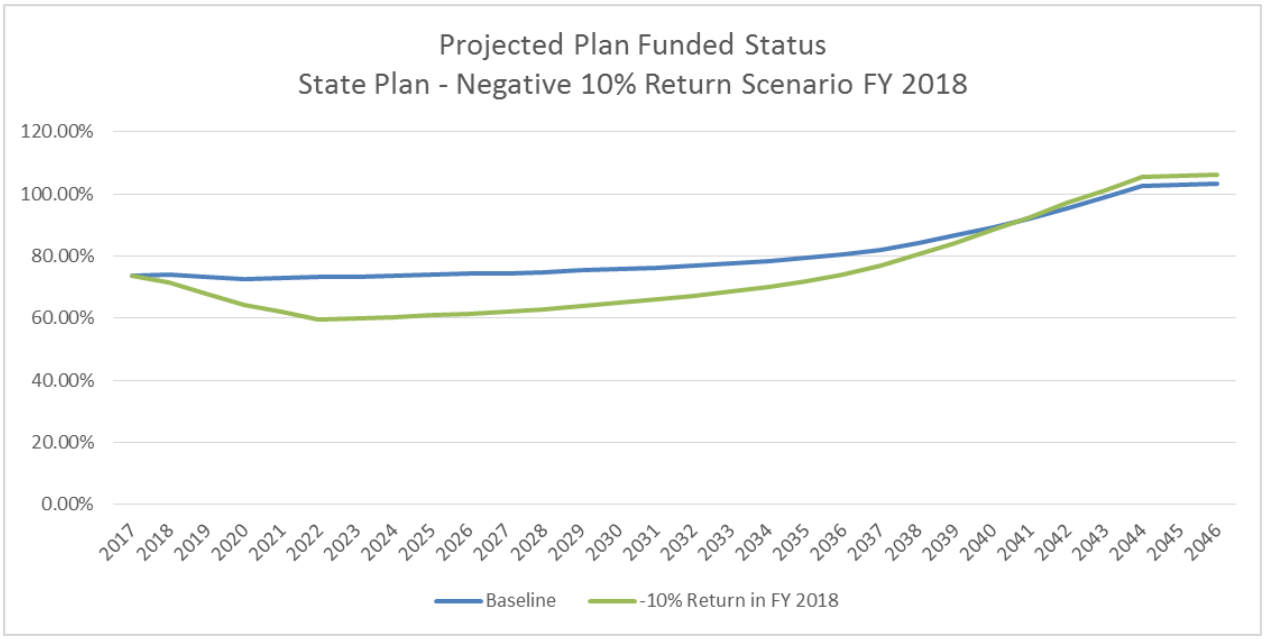


Exhibit 38

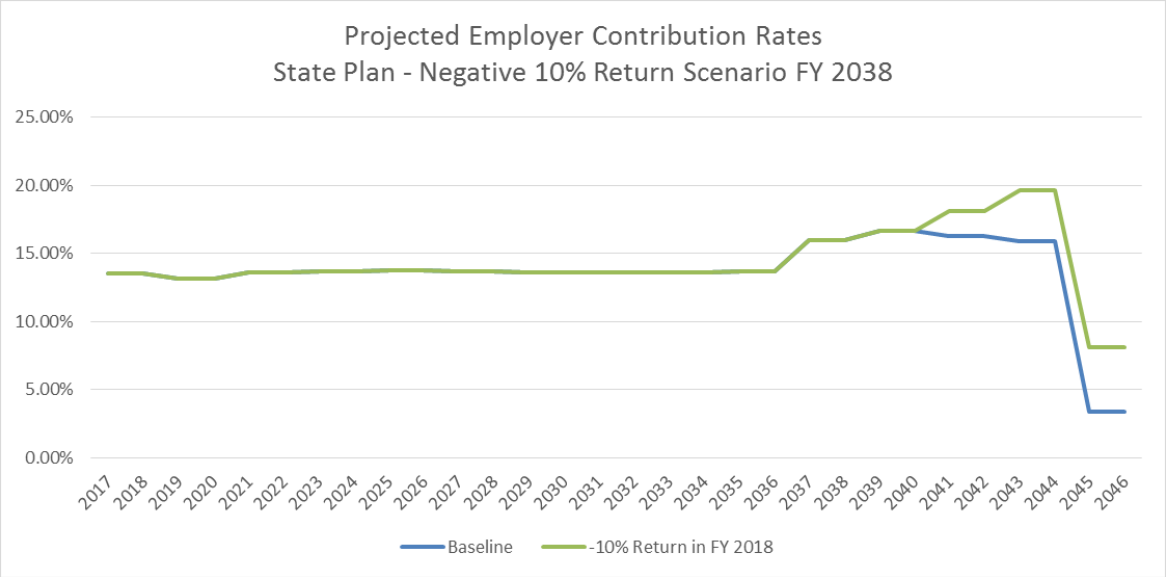
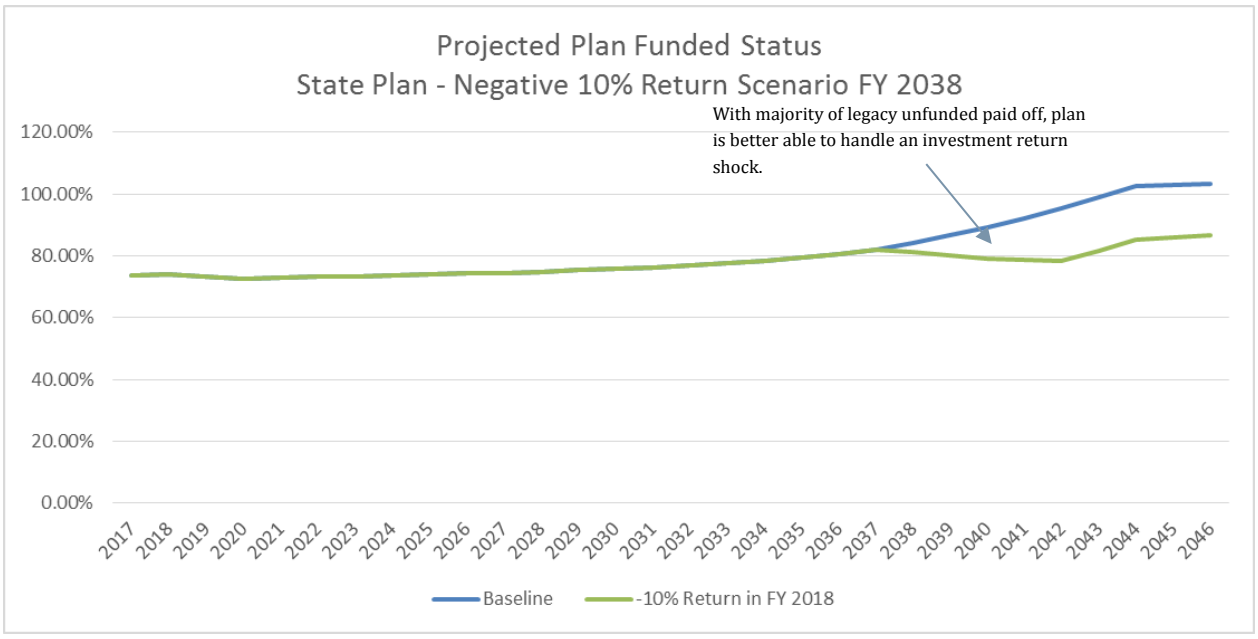


Exhibit 39



Stochastic Projections

Stochastic analysis reflects the realistic view that pension plan investment returns, like the market itself, may be volatile and uncertain. Rather than using exact assumptions, the model uses probability distributions to provide a range of possible results based on these probabilities.

We modeled employer contribution results using a stochastic (or probabilistic) component for both the State and Teacher plan to provide a range of possible results in the future.

The stochastic projections are based on the capital market assumptions and the asset allocation used in the recent plan experience study. The projections are based on the June 30, 2016 actuarial valuations of the State and Teacher plans, including the assumption and method experience study changes recently adopted by the VRS Board. This includes setting of contribution rates for future biennia and reflecting the new methodology developed with the experience study to estimate contribution rates based on the payroll for hybrid and non-hybrid members projected two years from the valuation date.

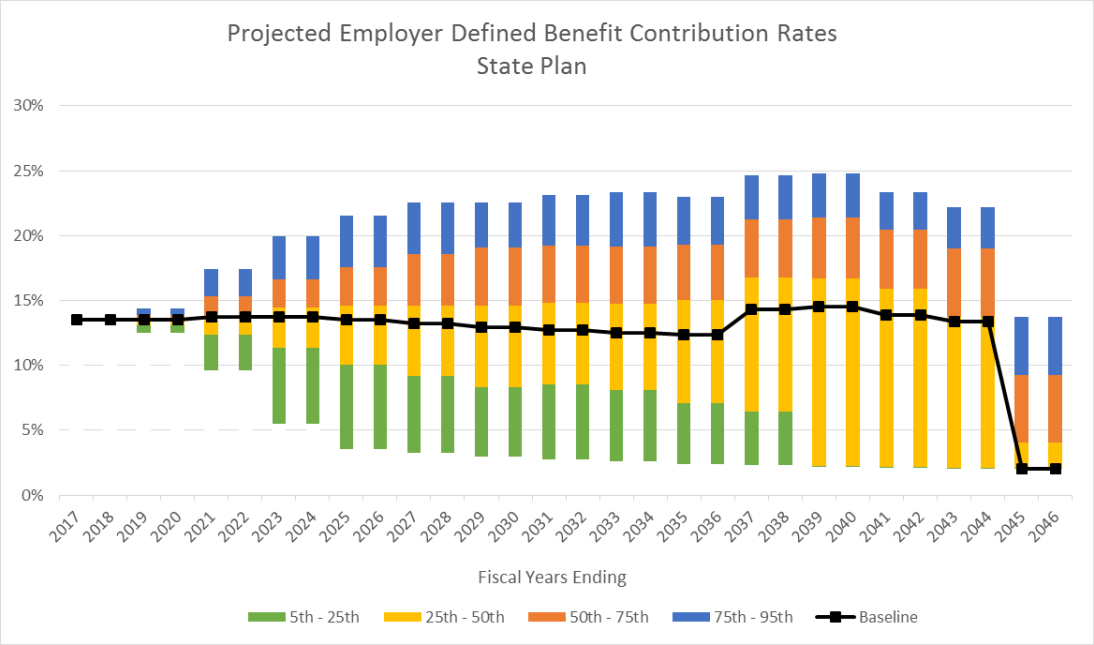
The baseline contribution rates are based on the deterministic projections, including 7% assumed rate of investment return.

The projections are intended to present general contribution rate trends under varying economic scenarios and helps to quantify the likelihood and magnitude of possible future outcomes.

State Plan

The baseline deterministic model shows that the State defined benefit contribution rates should remain relatively level over the next 20 years, with an expected employer rate of 12.34% for the defined benefit component in 2036. The stochastic model provides an estimated probability of where contributions rates could fall. For example, in year 2036 there is a 50% chance that the contribution rate will fall within a range of 7.09% - 19.27%, with the 50th percentile being 15.0%. The model also shows that there is a 25% chance that the rate could exceed 19.27%, as well as a 25% chance that the employer rate could be less than 7.09% in 2036.

Exhibit 40

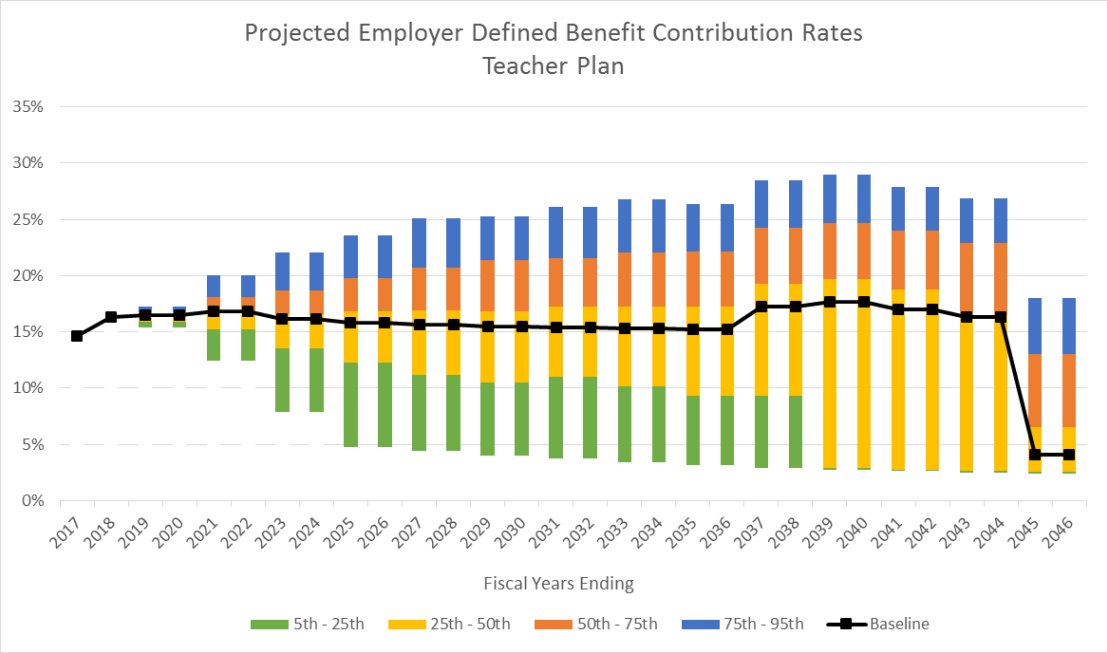


Stochastic modeling does not include matching contributions associated with the defined contribution component of the hybrid plan.

Teacher Plan

The baseline deterministic model shows that the Teacher defined benefit contribution rates should also remain relatively level over the next 20 years, with an expected employer rate of 15.18% for the defined benefit component in 2036. The stochastic model provides an estimated probability of where contributions rates could fall. For example, in year 2036 there is a 50% chance that the contribution rate will fall within a range of 9.36% - 22.17%, with the 50th percentile being 17.26%. The model also shows that there is a 25% chance that the rate could exceed 22.17%, as well as a 25% chance that the employer rate could be less than 9.36% in 2036.

Exhibit 41



Stochastic modeling does not include matching contributions associated with the defined contribution component of the hybrid plan.

FINDINGS AND CONCLUSIONS

Understanding pension risk is a difficult, but necessary, aspect of understanding pension plans. From a wide range of possible future outcomes, actuarial valuations determine single-point measures of the pension liability and actuarially determined contribution. However in accepting these measures, it is also important to understand the range of possibilities and the associated risks.

- Investment policy has met its long-term target rate of return of the past twenty-five years.
- Over the past twenty-five years pension contributions, on average, have been 25-30 percent less than what was actuarially required.
- Benefit improvements and unfunded liabilities added significant costs to the state-wide plans at the same time underfunding was decreasing income to the plans.
- Past practices have created significant affordability challenges in the short term, but pension reforms have lessened potential future liabilities and introduced risk sharing with new members. State-wide plans will have higher than normal contribution rates until the legacy unfunded liability is paid off in 2043.

Since 2010 the Commonwealth has undertaken a series of major pension reform initiatives and addressed plan costs and liabilities by:

- Implementing plan design changes, including the introduction of the Hybrid Retirement Plan
- Committing to fully funding the actuarially required contribution rates by fiscal year 2019.
    - This occurred two years ahead of schedule for the State plans, and is scheduled to occur one year ahead of schedule for the Teacher plan.
- Accelerating payback of deferred contributions from the 2010-2012 biennium
    - Paid back State plans 5 years of ahead of schedule.
    - Paid down additional $193 million of Teacher deferred contribution balance in 2015.

The plan design changes mostly impacted new or future employees and therefore will show the greatest impact over time as new members enter into VRS.

VIRGINIA ACTS OF ASSEMBLY -- 2017 SESSION

CHAPTER 639

An Act to require the Virginia Retirement System to adopt stress testing and reporting policies.

[H 1768]

Approved March 20, 2017

Be it enacted by the General Assembly of Virginia:

1. *§ 1. The Virginia Retirement System (VRS) shall adopt a formal policy to:*

1. Develop and regularly report sensitivity and stress test analyses. Such analyses and reporting shall include projections of benefit levels, pension costs, liabilities, and debt reduction under various economic and investment scenarios;

2. Improve investment transparency and reporting policy by (i) providing a clear and detailed online statement of investment policy; (ii) including one-year, three-year, five-year, and 10-year investment performance data in quarterly investment reports; (iii) including 20-year and 25-year investment performance data in annual investment reports; (iv) reporting net investment returns on a quarterly basis; and (v) reporting gross investment returns and returns by asset class on an annual basis; and

3. Regularly report investment performance and expenses such as external manager fees, carried interest fees, and investment department expenses for all asset classes, including private equity, public equity, fixed income, credit strategies, real assets, strategic opportunities, and other investments.