

March 7, 2018



The Analytic Foundation for the 2018-2019 SERS Strategy Investment Plan: Background, Education and Decision Framework

Commonwealth of Pennsylvania Employees' Retirement System



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Purpose

This presentation has three objectives:

1. Provide the background and analytic foundation for the SERS Board's asset allocation decision, the key element in the Board's 2018-2019 Strategic Investment Plan. This analytic foundation is the result of collaboration between RVK and SERS senior investment staff.
2. Provide sufficient information and explanation regarding the key methods and data employed in creating the underlying foundation for the Board's deliberation and decision as well as key factors we recommend it consider.
3. Provide the Board with a comprehensive comparative analysis of the four prospective asset allocations currently under consideration—addressing all key factors.

The Key Points

- From the viewpoint of the last Asset/Liability Study, SERS continues to be a gradually maturing DB pension plan, with a need for high return seeking investment exposures and a sustained commitment to broad diversification to manage risk. But, a return to full funding requires a sustained actuarially determined contribution stream and a constant monitoring of fund liquidity.
- Asset allocation is the single most powerful determinant of total SERS fund return, risk and investment expense. SERS has a disciplined process for determining and periodically reviewing the fund's asset allocation which is critical *as a fund without an agreed upon asset allocation is a fund without a strategy.*

The Key Points

- Choosing an appropriate asset allocation is difficult in that the decision involves many trade-offs—expected risk versus expected return, expected return versus the probability of meeting the assumed rate of return, illiquidity risk versus expected return, etc. Alternative asset allocations, though, can be compared on a variety of criteria against which the SERS Board fiduciary judgment can be applied.
- Choosing an asset allocation in the current market environment is particularly difficult given the high returns of the past seven years and the prospect that returns may be lower over the next ten years.
- The asset allocation options – 1 through 4 – currently under consideration all represent responsible choices, but the trade-off inherent in each of them can differ materially.
- The SERS fund appears to have sufficient liquidity to withstand substantial declines in the equity market and thus in the total fund. However, if such declines were to be accompanied by *employer* contributions lower than those actuarially required or persist longer than a year, the fund might be forced to sell equity securities at depressed values but could still ensure that benefits due retirees were paid in full and on time.

Asset/Liability Match

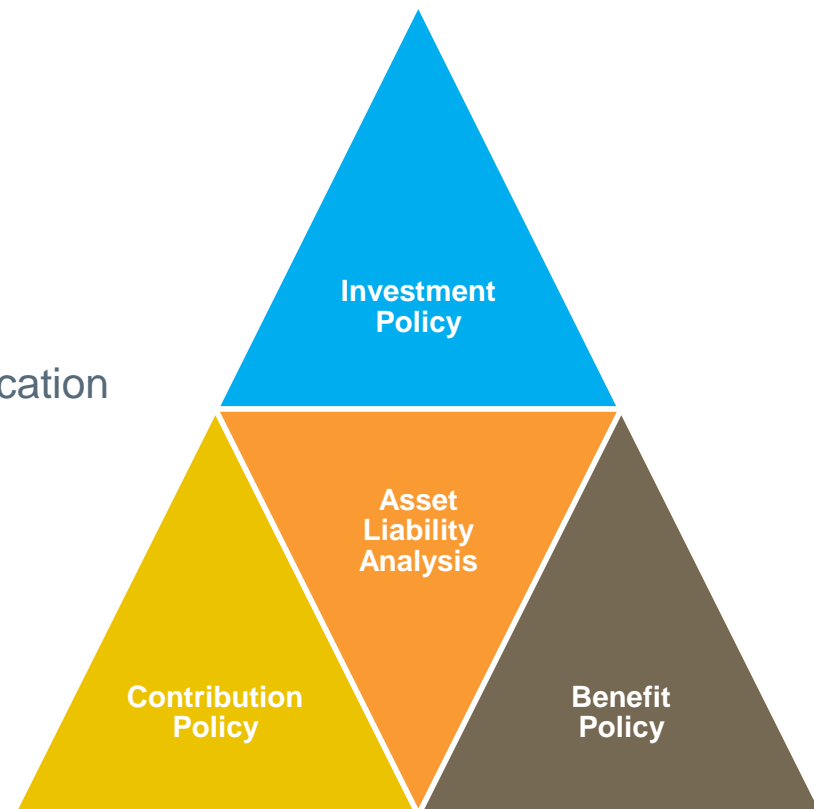


The Foundation – SERS Asset/Liability Match

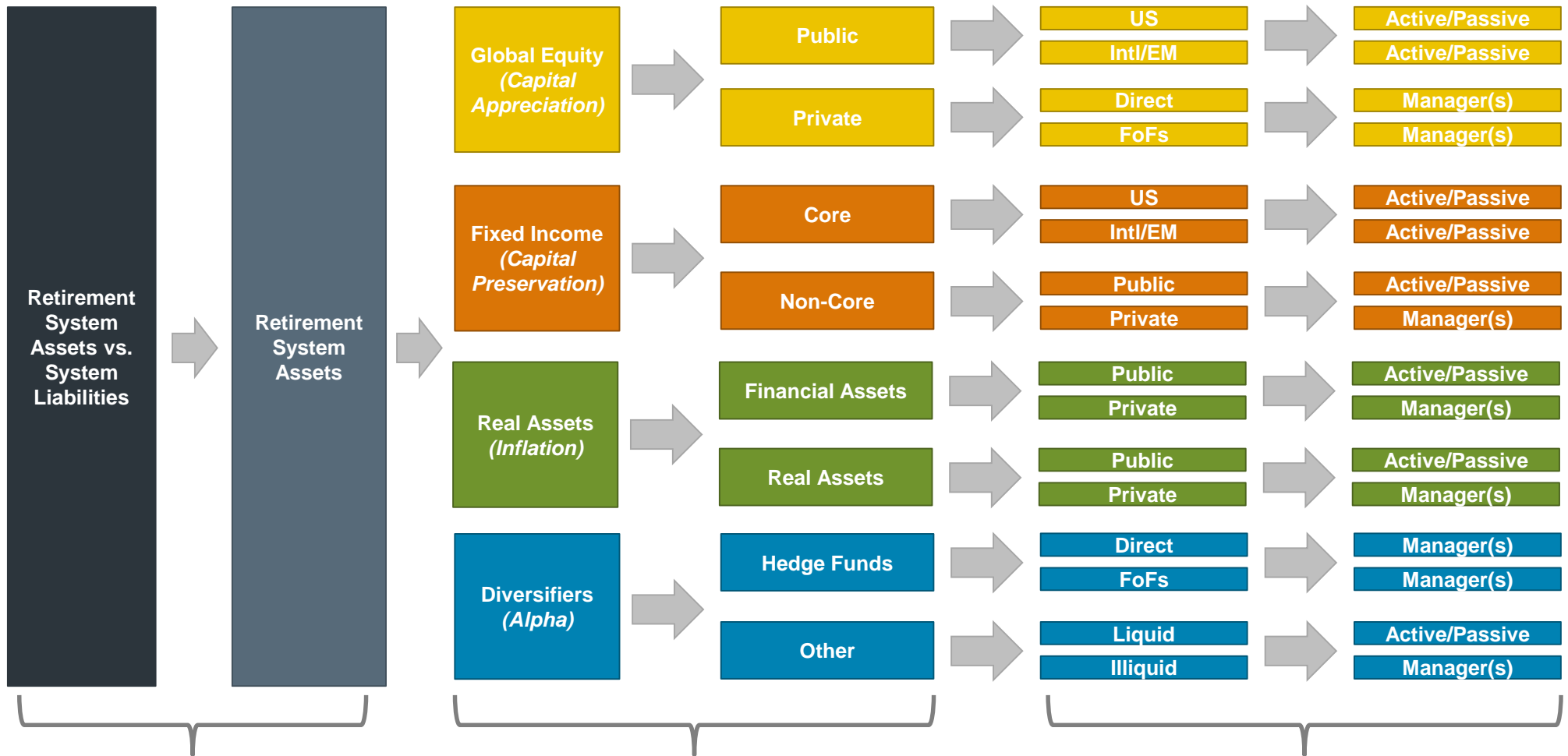
- There is only one analytic viewpoint – i.e. Asset/Liability study – which brings together all three critical elements of a public defined benefit plan – benefit policy, contribution policy and investment strategy.
- Only through the lens of an A/L study can the Board get a truly holistic view of the plan as current constructed and assess it's potential behavior going forward.

Because the A/L viewpoint of the SERS plan...

- Is the only truly holistic view
- Informs (though does not determine) asset allocation



The Foundation – SERS Asset/Liability Match



Asset/Liability Study

- Assesses health of Plan
- Models general risk and return parameters
- Links Investment Policy, Contribution Policy, and Benefit Policy

Asset Allocation Study

- Models specific targets to asset classes
- Used to select overall target allocation
- Uses passive assumptions

Asset Class Structure Studies

- Implementation guide with targets to sub-asset classes
- Mix of active and passive investments determined
- Optimal mix of managers

Key Takeaways from the Most Recent A/L Study

RVK conducted the last A/L study of the SERS plan in 2015 (based on the CY 2014 Actuarial Valuation and Investment Performance). There have been many changes in the SERS DB plan since that time. These include several important ones from an A/L perspective:

1. The SERS Board lowered its assumed rate of return from 7.50% to 7.25%.
2. The plan's demographics have matured further with the number of retirees relative to active members rising.
3. The assets available to pay benefits (liabilities) have risen from \$27.6 billion as of 12-31-2014 to \$29.4 billion as of 12-31-2017.

Key Takeaways from the Most Recent A/L Study

Given these changes since 2015, we must take care in assessing the degree to which the key conclusion of that A/L study apply to and inform the Board's current decisions related to the 2018-2019 Strategic Investment Policy.

With that caveat, RVK believes the following conclusions reached in the 2015 study are still quite likely to be material to current SERS Board decision-making:

- The achievement of a sustained contribution policy assuring the Actuarially Required Contribution (ARC) is made to the SERS plan is critical to the gradual improvement of its funded status (i.e. its ability to eventually build assets sufficient to pay all actuarially estimated benefits).
- Even with a sustained stream of ARC-based contributions and a stable and generally favorable investment performance (relative to expectations), progress toward full funding of the SERS DB plan will most likely take several decades or longer.

Key Takeaways from the Most Recent A/L Study

The investment strategy that best meets the following set of objectives...

- improves the plan's ability to pay benefits
- avoids higher downside risk
- avoids unusually high dependence on contributions (vs. investment returns) to improve the fund's financial health

...relies on a highly diversified, risk aware, total return seeking asset allocation.

This investment strategy (and its implementing asset allocation) will need to pursue returns from multiple sources, including returns associated with illiquid investments. However, in consideration of the increasing maturity of the plan's demographics and the need to protect against material downturns in the equity market, it must also contain limits on the degree of illiquidity embedded in the fund. Moreover, the appropriate reliance on illiquid investments will likely decline at a very slow pace over the coming several decades as plan demographics continue to mature.

Hewing to a highly conservative investment strategy (and its implementing asset allocation) will almost certainly increase the costs of the plan by increasing required employer contributions.

Asset Allocation



Asset Allocation – What is It?

A Disciplined Plan for an Uncertain Future Investment Environment.

- Investors have choices for investing their assets in the pursuit of desired net of fee returns at acceptable levels of risk. Large institutional investors have a particularly wide set of choices.
- By choices, we don't mean managers or specific investment products. We mean –
 - Fundamental investments in such as economic growth (equities), credit/lending (fixed income), real assets (real estate, land, timber, etc.).
 - And aspects of allocating assets to these fundamental investments that can themselves produce returns – size, value, momentum, pricing inefficiency, illiquidity, skill.
- Anyone can recount what has already happened in the capital markets (especially what has done well recently). All this is now history. ***The critical challenge for investors is constructing their investment exposures to achieve their objectives not knowing with any degree of certainty what will happen in the future.***
- Asset allocation is the process of arranging the long-term fundamental investment exposures of the fund in light of investment objectives, acceptable risk and the best reflection of the likely long-term path of each in the coming 10+ years.

Asset Allocation – Why It Matters

Strategic asset allocation is the most powerful determinant of total fund performance in the long run.

While good manager evaluation decisions will unquestionably add to performance, they cannot make up for a poorly diversified and/or inefficient allocation.

Strategic allocation is the most powerful determinant of total fund risk in the long run.

Multiple studies calculated the effects of asset allocation on portfolio returns and concluded that asset allocation “drives” portfolio returns.

Asset Allocation Explains:

100% of Return Amount Over Time

- Studies consistently find that funds making timing and selection bets against their long-term policy mix are unsuccessful in adding significant value by engaging in timing and/or manager selection.

90% of Return Variability Over Time

- Studies consistently conclude that roughly 90% of the movement of a fund’s total return is explained by target policy fluctuation.

Asset Allocation – Mean Variance Optimization

Using inputs of expected return, volatility, and correlation, Mean Variance Optimization (MVO) enables investors to identify combinations of distinct asset class allocations that *maximize portfolio returns for a given level of risk*.

MVO Benefits

- Illustrates the critical concept of diversification, which encourages investors to avoid concentrating risk in a small subset of assets or asset classes, especially closely related (highly-correlated) ones.
- Focuses portfolio management activities on asset allocation, which is the most important driver of overall portfolio risk and return.
- Provides a powerful quantitative tool to identify distinct asset allocation targets that have the most optimal risk/return tradeoffs.

MVO Shortcomings

- Simplified assumption of risk/return trade-off may fail to capture fully how a specific investor weighs gains versus losses (i.e., do losses matter more than gains?)
- Volatility is viewed as the only proxy for risk.
- Correlation is treated as static rather than dynamic.
- Models are sometimes highly sensitive to small changes to input values (“robustness”).
- Unconstrained output yields highly concentrated portfolios rather than the expected diversification.

Asset Allocation – Capital Market Assumptions

No one knows with any certainty the investment environment that will emerge over the next 10+ years.

Capital Market Assumptions (CMA's) essentially create a “best estimate” of that future environment.

The future characteristics are estimated of every individual asset class (e.g., U.S equity, U.S corporate fixed income, real estate, private equity, cash, etc.) is estimated in three fundamental and one derivative respect –

Fundamental

- **Return (arithmetic)** The expected return for any given year along a 10+ year path
- **Risk (volatility)** The expected variability of that return over this same period
- **Correlation** The degree to which returns for each asset class is expected to vary in concert with those of the other asset classes











Derivative

- **Return (compound)** The expected return over the entire period considering the expected volatility of the those returns along the way

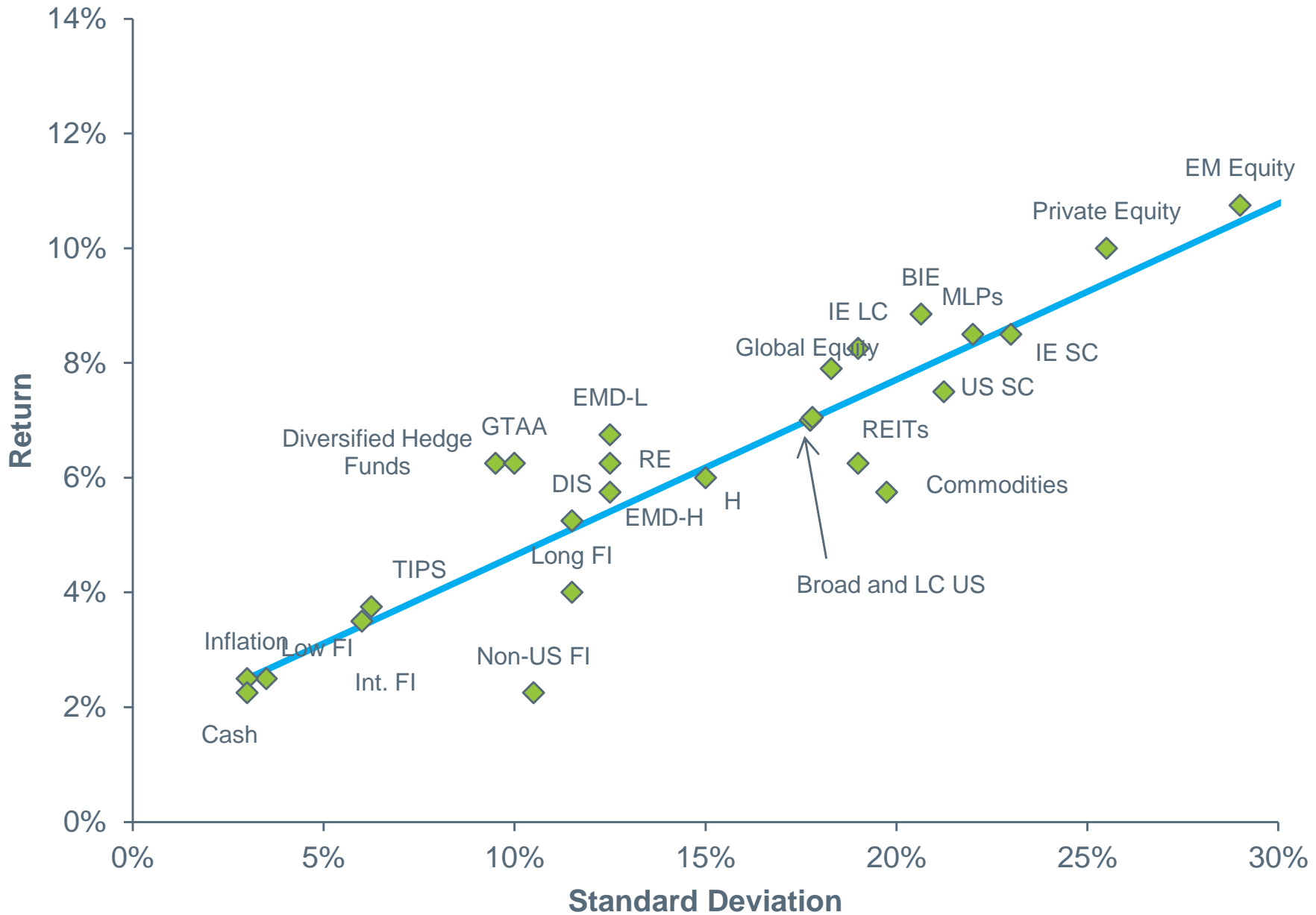
RVK's 2018 Capital Market Assumptions

Asset Class	Benchmark	2017			2018			Change (2018 - 2017)		
		Nominal Return (Arith.)	Standard Deviation	Nominal Return (Geo.)	Nominal Return (Arith.)	Standard Deviation	Nominal Return (Geo.)	Nominal Return (Arith.)	Standard Deviation	Nominal Return (Geo.)
Large/Mid Cap US Equity	S&P 500 (Cap Weighted)	7.00%	17.75%	5.56%	6.75%	17.75%	5.30%	-0.25%	0.00%	-0.25%
Small Cap US Equity	Russell 2000	7.50%	21.25%	5.46%	7.25%	21.25%	5.20%	-0.25%	0.00%	-0.25%
Broad US Equity	Russell 3000	7.05%	17.80%	5.60%	6.80%	17.80%	5.35%	-0.25%	0.00%	-0.25%
Dev'd Large/Mid Cap Int'l Equity	MSCI EAFE (Gross)	8.25%	19.00%	6.62%	8.00%	19.00%	6.37%	-0.25%	0.00%	-0.25%
Dev'd Small Cap Int'l Equity	MSCI EAFE Small Cap (Gross)	8.50%	23.00%	6.14%	8.25%	23.00%	5.89%	-0.25%	0.00%	-0.26%
Emerging Markets Equity	MSCI Emerging Markets (Gross)	10.75%	29.00%	7.14%	10.25%	29.00%	6.62%	-0.50%	0.00%	-0.51%
Broad International Equity	MSCI ACW Ex US IMI (Gross)	8.85%	20.65%	6.94%	8.60%	20.80%	6.66%	-0.25%	0.15%	-0.28%
Global Equity	MSCI ACW IMI (Gross)	7.90%	18.30%	6.38%	7.65%	18.35%	6.12%	-0.25%	0.05%	-0.26%
Intermediate Duration Fixed Income	Bloomberg US Aggregate Bond	3.50%	6.00%	3.33%	3.50%	6.00%	3.33%	0.00%	0.00%	0.00%
Non-US Dev'd Sovereign Fixed Income UH	Citi Non-US World Gov't Bond	2.25%	10.50%	1.72%	2.25%	10.50%	1.72%	0.00%	0.00%	0.00%
Emerging Markets Debt Hard Currency	JPM EMBI Global Diversified	5.75%	12.50%	5.02%	5.25%	12.50%	4.52%	-0.50%	0.00%	-0.50%
Emerging Markets Debt Local Currency	JPM GBI EM Global Diversified	6.75%	12.50%	6.03%	5.75%	12.50%	5.02%	-1.00%	0.00%	-1.01%
TIPS	Bloomberg US Treasury: US TIPS	3.75%	6.25%	3.56%	3.75%	6.25%	3.56%	0.00%	0.00%	0.00%
Low Duration Fixed Income	Bloomberg US Gov't/Cred: 1-3 Year	2.50%	3.50%	2.44%	3.00%	3.50%	2.94%	0.50%	0.00%	0.50%
Long Duration Fixed Income	Bloomberg US Gov't/Cred: LT Bond	4.00%	11.50%	3.37%	3.50%	11.50%	2.87%	-0.50%	0.00%	-0.50%
High Yield	Bloomberg US Corp: High Yield	6.00%	15.00%	4.95%	5.50%	15.00%	4.45%	-0.50%	0.00%	-0.50%
Core Real Estate	NCREIF ODCE (Gross) (AWA)	6.25%	12.50%	5.52%	6.25%	12.50%	5.52%	0.00%	0.00%	0.00%
Global REITs	MSCI World Real Estate Index (Gross)	6.25%	19.00%	4.59%	6.25%	19.00%	4.59%	0.00%	0.00%	0.00%
MLPs	Alerian MLP Index	8.50%	22.00%	6.34%	8.50%	22.00%	6.34%	0.00%	0.00%	0.00%
Diversified Hedge Funds	HFRI Fund of Funds Composite Index	6.25%	9.50%	5.83%	5.75%	9.50%	5.33%	-0.50%	0.00%	-0.50%
GTAA	Custom GTAA Index	6.25%	10.00%	5.78%	6.00%	10.50%	5.48%	-0.25%	0.50%	-0.30%
Private Equity	Cambridge US Private Equity Index	10.00%	25.50%	7.16%	9.75%	25.50%	6.90%	-0.25%	0.00%	-0.26%
Commodities	Bloomberg Commodity Index	5.75%	19.75%	3.95%	5.75%	19.75%	3.95%	0.00%	0.00%	0.00%
Diversified Inflation Strategies	Custom DIS Index	5.25%	11.50%	4.63%	5.25%	11.50%	4.63%	0.00%	0.00%	0.00%
US Inflation	Consumer Price Index	2.50%	3.00%	2.46%	2.50%	3.00%	2.46%	0.00%	0.00%	0.00%
Cash Equivalents	BofA ML 3 Mo US T-Bill	2.25%	3.00%	2.21%	2.50%	3.00%	2.46%	0.25%	0.00%	0.25%

Capital Market Assumption Trends Relative 2017

Asset Class	Return Expectations	Reason
US Equity		Current valuations are expensive.
Developed Int'l Equity		Recent strong performance led to decrease in expectations.
Emerging Markets Equity		Recent strong performance led to decrease in expectations.
Int. Duration Fixed Income		Expect future returns to be suppressed due to low present yields and potential losses due to rising interest rates. But, rising interest rates will result in higher yields long term.
Emerging Markets Debt		Tightening spreads and lower yields.
Real Estate		With capitalization rates below historical averages but spreads slightly above, we assume no valuation adjustment.
MLPs		Considering valuations and a variety of energy industry concerns and uncertainties we maintain no change.
Hedge Funds		Growth and crowding in the hedge fund space.
Private Equity		Increased deal valuation multiples and higher equity requirements.
Commodities		Muted economic growth, potential for increasing commodity supply, and higher debt levels.

Checking the Reasonableness of our Map



Expected Returns shown are arithmetic.

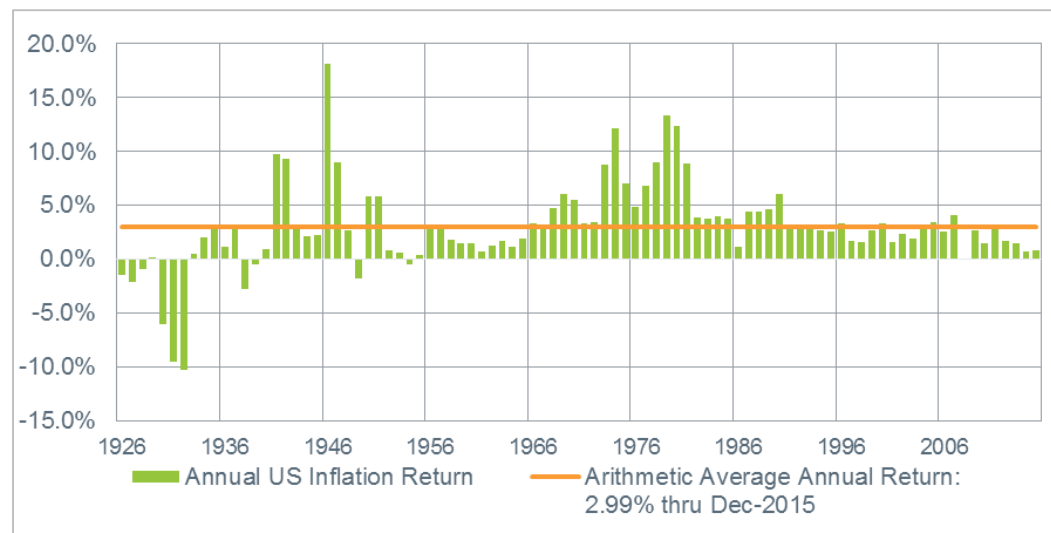
Asset Allocation – Wrapping up Some Final Points

Assumptions Do Not Assume Manager Excess Return

- Index data is used to construct capital markets assumptions, both return and risk figures.
- Asset classes such as Real Estate utilize peer group indexes, as investable market indexes do not exist.
- The active management component of forward-looking assumption is addressed at the asset class using a slightly different, but related approach.
- As the most important factor for long-term returns is asset allocation targets, using passive assumptions is more reliable during the portfolio construction process.

Inflation Assumption

- RVK's current long-term inflation assumption is 2.50%. Historical inflation rates are shown below.



Customizing the Asset Allocation Process for SERS

Because SERS has some unique implementations of some fundamental investment exposures, RVK – using combinations of our core capital market assumptions – creates several customized return/risk/correlation assumptions for several asset classes deployed in the SERS fund.

The specific CMA's used in the comparative analysis of SERS asset allocations later in this document are shown below. Only those with accompanying footnotes are custom assumptions and all are derivative of combinations of our core CMA's.

Asset Class	Arithmetic Return Assumption	Standard Deviation Assumption
Global Equity	7.65	18.35
Fixed Income*	3.76	5.84
Real Estate**	7.76	16.19
Multi-Strategy***	6.94	13.92
Private Equity	9.75	25.50
Cash Equivalents	2.50	3.00

*Fixed Income is comprised of 70% Intermediate Duration Fixed Income, 20% TIPS, 5% High Yield, and 5% EMD Local.

**Real Estate is comprised of 35% Core Real Estate, 55% Non-Core Real Estate, and 10% REITs.

***Multi-Strategy is comprised of 45% Private Credit, 45% Diversified Hedge Funds, and 10% Bank Loans.

Constraints: Human Judgment Tempers Math

Applying constraints represent a final step before using MVO to produce an asset allocation analysis.

What are the constraints specific to SERS? They set hard boundaries for the MVO process in the exploration of the 5000 different allocations to the asset classes. These instruct the MVO software to ignore asset allocations that – for example – would have allocations to:

- Global equity less than 25% or greater than 60%
- Fixed income less than 10% or greater than 25%
- Real estate less than 5% or greater than 15%
- Multi-strategy less than 5% or greater than 15%
- Private equity less than 10% or greater than 20%
- Cash equivalents less than 2% or greater than 6%

Why do we apply constraints? Three reasons:

1. The judgment that, regardless what the MVO software might say when driven by our CMA's (assumptions), a portfolio with less than 25% global equity or more than 25% fixed income simply doesn't make sense.
2. The known tendency of computer driven MVO modeling to first assign large amounts of the available assets to the asset class whose assumptions are just slightly better than the next most attractive asset class.
3. Humility regarding the degree of precision in our assumptions.

Understanding Asset Allocation Outcomes

Every asset allocation study RVK executes provides a broad array of information about the *expected* behavior of a specific asset allocation over the next 10+ years.

Some of the most important items in the information about *expected* outcomes for a specific asset allocation under consideration includes:

- | | |
|-----------------------------------|---|
| Return (annual arithmetic) | The expected return for any given year along a 10+ year path |
| Return (annual geometric) | The expected return over the entire period considering the volatility of the those returns along the way |
| Risk (volatility) | The expected variability of that return over this same period |
| Risk (downside) | The expected maximum decline in the total fund's value and probability that it will occur during this 10+ year period |
| Risk (actuarial) | The probability that the median expected return from this asset allocation will coincide with the SERS' plan's assumed rate of return of 7.25%. |

Understanding Asset Allocation Outcomes

Risk (liquidity)

What is the degree of illiquidity embedded in the specific asset allocation under consideration

Risk (implementation)

How difficult would the transition be from the current asset allocation to the one under consideration? Would substantial assets have to be liquidated and moved to a new asset class? What is the “degree of difficulty” in the specific asset movements required to transition from the current asset allocation to the one under consideration?

Reward/Risk Tradeoff

How much expected return from an asset allocation under consideration is associated with the volatility risk SERS expects from that same asset allocation?

Fees

While asset allocation study CMA's are constructed to reflect “net of all fees” returns and so their expected outcomes are not dependent on fees, that does not mean the total fees associated with a specific asset allocation are not of potential interest to the Board. And asset allocation decisions drive the fund's total fees paid.

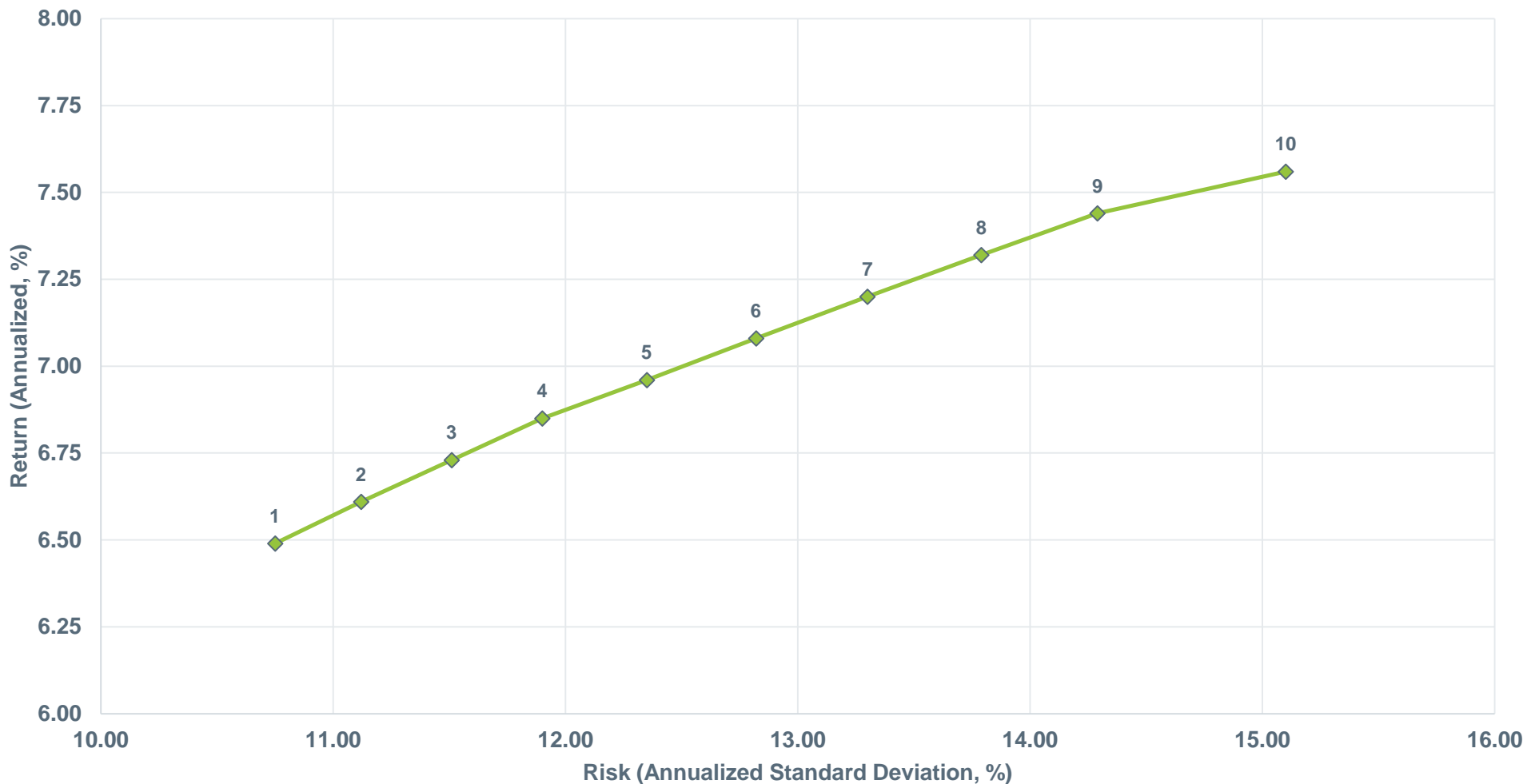
Creating the SERS Efficient Frontier

The table below shows the range of possible optimal allocations given the selected asset classes and constraints listed under “Min” and “Max.” This range illustrates the tradeoff between return and risk; additional return can only be achieved by undertaking additional risk.

		Constraints		Optimal Allocations									
		Min	Max	1	2	3	4	5	6	7	8	9	10
Asset Classes	Global Equity	25	60	29	25	26	26	25	28	31	34	37	48
	Fixed Income	10	25	25	25	25	25	23	20	17	14	11	10
	Real Estate	5	15	15	15	15	15	15	15	15	15	15	15
	Multi-Strategy	5	15	15	15	15	15	15	15	15	15	15	5
	Private Equity	10	20	10	14	15	17	20	20	20	20	20	20
	Cash Equivalents	2	6	6	5	3	2	2	2	2	2	2	2
Total				100	100	100	100	100	100	100	100	100	100
Thematic Buckets	Capital Appreciation			57	57	59	61	62	65	67	70	73	80
	Capital Preservation			24	23	21	20	18	16	14	12	10	9
	Alpha			7	7	7	7	7	7	7	7	7	2
	Inflation			13	13	13	13	13	12	12	11	11	9
Optimizing Return and Risk	Expected Return			6.49	6.61	6.73	6.85	6.96	7.08	7.20	7.32	7.44	7.56
	Risk (Standard Deviation)			10.75	11.12	11.51	11.90	12.35	12.82	13.30	13.79	14.29	15.10
	Return (Compound)			5.95	6.03	6.11	6.19	6.25	6.32	6.38	6.44	6.50	6.52
	Return/Risk Ratio			0.60	0.59	0.58	0.58	0.56	0.55	0.54	0.53	0.52	0.50
	RVK Expected Eq Beta (LCUS Eq = 1)			0.51	0.52	0.54	0.56	0.58	0.60	0.63	0.65	0.68	0.75
	RVK Liquidity Metric (T-Bills = 100)			60	57	56	54	52	52	52	52	52	59

Visualizing the SERS Efficient Frontier

The figure below illustrates visually the relationship between risk and return. The line connecting the points represents all the optimal portfolios subject to the given constraints and is known as the “efficient frontier.” The upward slope of the efficient frontier indicates the direct relationship between return and risk.

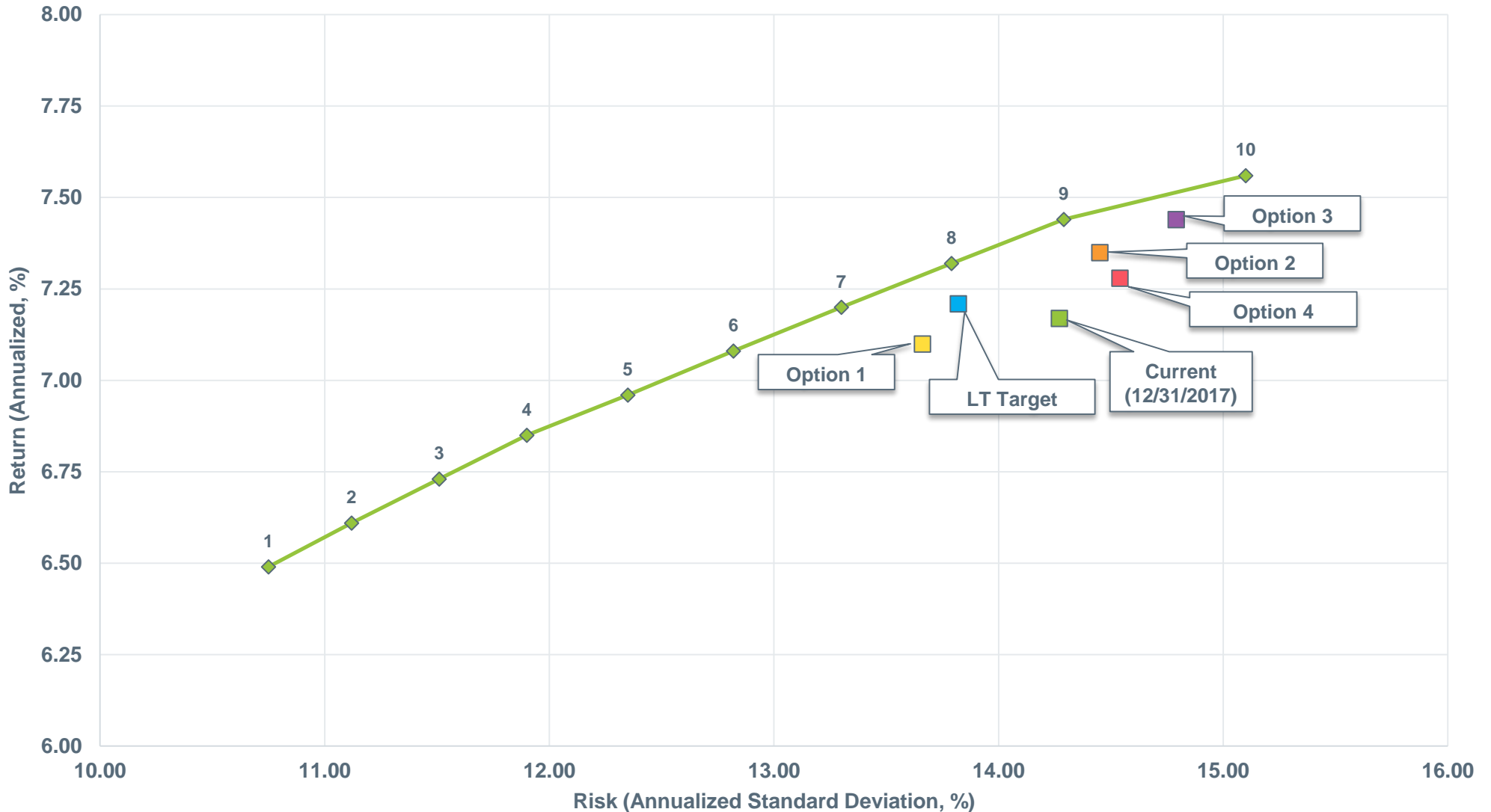


Comparing the Four Asset Allocation Options

	Min	Max	Current (12/31/2017)	LT Target	Option 1	Option 2	Option 3	Option 4
Global Equity	25	60	53	43	48	48	50	53
Fixed Income	10	25	14	14	18	11	10	14
Real Estate	5	15	8	12	10	12	12	9
Multi-Strategy	5	15	8	12	8	10	10	7
Private Equity	10	20	14	16	14	16	16	15
Cash Equivalents	2	6	3	3	2	3	2	2
Total			100	100	100	100	100	100
Capital Appreciation			76	72	73	76	78	78
Capital Preservation			13	13	15	11	9	12
Alpha			4	5	4	5	5	3
Inflation			7	9	9	9	8	8
Expected Return			7.17	7.21	7.10	7.35	7.44	7.28
Risk (Standard Deviation)			14.27	13.82	13.66	14.45	14.79	14.54
Return (Compound)			6.23	6.33	6.24	6.39	6.44	6.31
Return/Risk Ratio			0.50	0.52	0.52	0.51	0.50	0.50
RVK Expected Eq Beta (LCUS Eq = 1)			0.72	0.68	0.69	0.72	0.73	0.74
RVK Liquidity Metric (T-Bills = 100)			67	60	65	61	61	66

The Asset Allocations versus the Efficient Frontier

The efficient frontier shown below, now includes the plotted portfolios as represented within the table on the previous page.



The Probability of Achieving the SERS ARoR

The table below shows the **percentage** chance of achieving or exceeding the given return for each portfolio for the 1, 3, 5 and 10 year periods. SERS ARoR has been highlighted.

1 Year	1	2	3	4	5	6	7	8	9	10	Current (12/31/2017)	LT Target	Option 1	Option 2	Option 3	Option 4
Target 6.5%	52	53	53	53	54	54	54	55	55	55	53	54	53	54	54	53
Target 6.75%	51	52	52	52	53	53	53	54	54	54	52	53	52	53	53	52
Target 7%	50	50	51	51	52	52	52	53	53	53	51	52	51	52	52	51
Target 7.25%	49	49	50	50	51	51	52	52	52	52	50	51	50	51	51	51
Target 7.5%	48	48	49	49	50	50	51	51	51	51	49	50	49	50	51	49
Target 7.75%	46	47	48	48	49	49	50	50	51	50	48	49	48	50	50	49
3 Years																
Target 6.5%	50	51	52	53	53	53	54	54	54	54	52	53	52	53	53	52
Target 6.75%	48	49	50	51	51	52	52	53	53	53	50	52	51	52	52	51
Target 7%	46	47	48	49	50	50	50	51	52	51	49	50	49	51	51	50
Target 7.25%	44	46	46	47	48	48	49	50	50	50	48	49	48	49	50	48
Target 7.5%	43	43	45	46	46	47	48	48	49	49	46	47	46	48	48	47
Target 7.75%	41	41	43	44	45	46	46	47	48	47	45	46	45	47	47	46
5 Years																
Target 6.5%	50	51	52	53	54	54	55	55	56	55	53	54	53	54	55	53
Target 6.75%	48	49	50	51	52	52	53	53	54	53	51	52	51	52	53	51
Target 7%	46	47	48	49	50	51	51	51	52	51	49	50	49	50	51	50
Target 7.25%	43	44	45	46	48	48	49	50	50	49	47	48	47	49	49	48
Target 7.5%	41	42	43	44	45	46	47	48	48	48	46	46	45	47	47	46
Target 7.75%	38	39	41	42	43	44	45	46	46	46	44	44	43	45	46	45
10 Years																
Target 6.5%	48	49	51	52	53	54	54	55	55	54	51	53	51	53	54	52
Target 6.75%	44	46	47	48	50	51	52	52	53	52	49	50	49	51	51	50
Target 7%	41	43	44	46	47	48	49	50	50	50	47	48	46	48	49	47
Target 7.25%	38	40	41	43	44	45	46	47	48	47	44	45	44	46	47	45
Target 7.5%	35	36	38	39	41	42	43	44	45	45	42	43	41	44	44	43
Target 7.75%	32	34	35	37	38	39	41	42	43	43	40	40	39	41	42	41

Estimating Comparative Downside Risk

The table below shows the expected return by percentile for each portfolio for the 1, 3, 5 and 10 year periods.

1 Year	1	2	3	4	5	6	7	8	9	10	Current (12/31/2017)	LT Target	Option 1	Option 2	Option 3	Option 4
1st Percentile	-26.96	-26.84	-27.86	-28.41	-29.23	-30.57	-31.94	-33.29	-34.39	-37.58	-33.95	-33.44	-32.40	-34.83	-35.87	-34.58
5th Percentile	-9.66	-9.77	-10.11	-10.47	-10.85	-11.51	-12.01	-12.56	-13.26	-15.48	-14.27	-13.11	-13.38	-14.10	-14.56	-14.53
25th Percentile	1.34	1.37	1.24	1.20	1.09	0.91	0.73	0.53	0.36	-0.59	-0.60	0.09	-0.24	-0.33	-0.43	-0.65
50th Percentile	7.03	7.10	7.21	7.32	7.42	7.54	7.69	7.80	7.93	7.86	7.28	7.54	7.24	7.65	7.71	7.39
75th Percentile	12.80	12.93	13.25	13.55	13.84	14.29	14.70	15.08	15.55	16.64	15.84	15.30	15.37	15.97	16.26	16.12
95th Percentile	21.65	21.78	22.48	22.93	23.52	24.54	25.49	26.54	27.59	30.45	29.24	27.75	27.86	29.23	29.89	29.70
99th Percentile	28.28	28.71	29.66	30.57	31.46	32.74	34.25	35.40	36.76	40.72	39.34	36.69	37.22	38.77	39.64	39.95
3 Years																
1st Percentile	-12.58	-13.09	-13.71	-14.03	-14.64	-15.35	-16.36	-17.19	-18.41	-20.39	-17.67	-17.62	-16.83	-18.36	-19.22	-18.58
5th Percentile	-4.09	-4.04	-4.30	-4.49	-4.72	-5.07	-5.55	-6.01	-6.45	-7.81	-7.14	-6.49	-6.58	-7.15	-7.42	-7.34
25th Percentile	2.83	2.87	2.81	2.86	2.82	2.74	2.63	2.54	2.40	1.85	1.78	2.17	1.96	1.95	1.88	1.75
50th Percentile	6.53	6.64	6.73	6.84	6.96	7.04	7.11	7.15	7.25	7.28	6.82	7.05	6.87	7.10	7.17	6.95
75th Percentile	10.08	10.25	10.50	10.71	10.91	11.20	11.53	11.82	12.12	12.60	11.93	11.75	11.64	12.11	12.29	12.11
95th Percentile	14.98	15.20	15.62	15.96	16.34	16.91	17.51	18.04	18.61	19.97	18.97	18.29	18.32	19.18	19.57	19.31
99th Percentile	18.84	18.98	19.59	20.01	20.55	21.26	22.08	22.99	23.84	26.07	24.76	23.73	23.77	24.99	25.55	25.19
5 Years																
1st Percentile	-9.28	-9.37	-9.81	-10.16	-10.58	-11.29	-12.22	-13.24	-14.32	-15.07	-13.01	-13.25	-12.46	-14.06	-14.76	-13.78
5th Percentile	-2.01	-1.97	-2.17	-2.32	-2.50	-2.85	-3.18	-3.54	-3.92	-4.95	-4.30	-3.79	-3.93	-4.33	-4.57	-4.54
25th Percentile	3.44	3.56	3.55	3.57	3.57	3.53	3.45	3.34	3.21	2.78	2.68	3.03	2.88	2.88	2.85	2.68
50th Percentile	6.53	6.66	6.75	6.86	6.97	7.05	7.14	7.23	7.30	7.16	6.87	6.98	6.85	7.05	7.10	6.96
75th Percentile	9.29	9.44	9.65	9.83	10.03	10.25	10.49	10.73	10.96	11.35	10.75	10.69	10.57	10.98	11.14	10.92
95th Percentile	13.07	13.21	13.56	13.86	14.19	14.64	15.09	15.57	16.04	17.24	16.50	15.92	15.91	16.56	16.90	16.71
99th Percentile	16.07	16.27	16.77	17.12	17.48	18.06	18.68	19.39	20.03	21.59	20.65	19.78	20.02	20.67	21.11	21.01
10 Years																
1st Percentile	-4.50	-4.39	-4.66	-4.90	-5.17	-5.75	-6.29	-6.91	-7.75	-8.36	-7.61	-7.02	-6.85	-7.82	-8.28	-7.83
5th Percentile	0.10	0.18	0.06	-0.05	-0.16	-0.39	-0.65	-0.93	-1.18	-1.89	-1.58	-1.15	-1.25	-1.63	-1.77	-1.67
25th Percentile	4.08	4.17	4.18	4.19	4.22	4.17	4.14	4.10	4.06	3.67	3.63	3.86	3.73	3.73	3.71	3.62
50th Percentile	6.34	6.45	6.54	6.64	6.74	6.82	6.90	6.98	7.06	6.96	6.61	6.78	6.62	6.81	6.86	6.69
75th Percentile	8.34	8.50	8.66	8.84	9.00	9.17	9.36	9.55	9.72	9.96	9.42	9.44	9.32	9.66	9.80	9.57
95th Percentile	11.19	11.34	11.63	11.88	12.11	12.47	12.81	13.15	13.48	14.24	13.49	13.25	13.15	13.70	13.95	13.71
99th Percentile	12.95	13.06	13.40	13.69	14.07	14.50	14.88	15.30	15.75	16.88	16.07	15.58	15.63	16.27	16.54	16.38

The Range of Potential Expected Outcomes

The chart below focuses on the expected return by percentile for potential asset allocation Option 2 for the 1, 3, 5 and 10 year periods.

Monte Carlo Simulations -
Expected Return by Percentile for Option 2



Downside Risk and Liquidity – Two Scenarios

The comparative expected relative liquidity and downside risk of the four asset allocations have been addressed individually earlier in the presentation (pages 27 and 30, respectively).

However, downside risk and liquidity (or more specifically illiquidity) have a special risk that should be considered in that they can, under certain conditions, interact in a fashion detrimental to the health of the fund.

Specifically, in the event of a significant decline the most volatile allocation in the fund – equity – if the decline is large enough and the degree of illiquidity in the fund substantial enough, the fund may be forced to pay benefits by either

- Selling equities at the low point in their performance cycle

Or

- Attempting to sell illiquid partnership interests in the secondary market which, in many capital markets environments, may mean material haircuts to current value.

Downside Risk and Liquidity – Two Scenarios

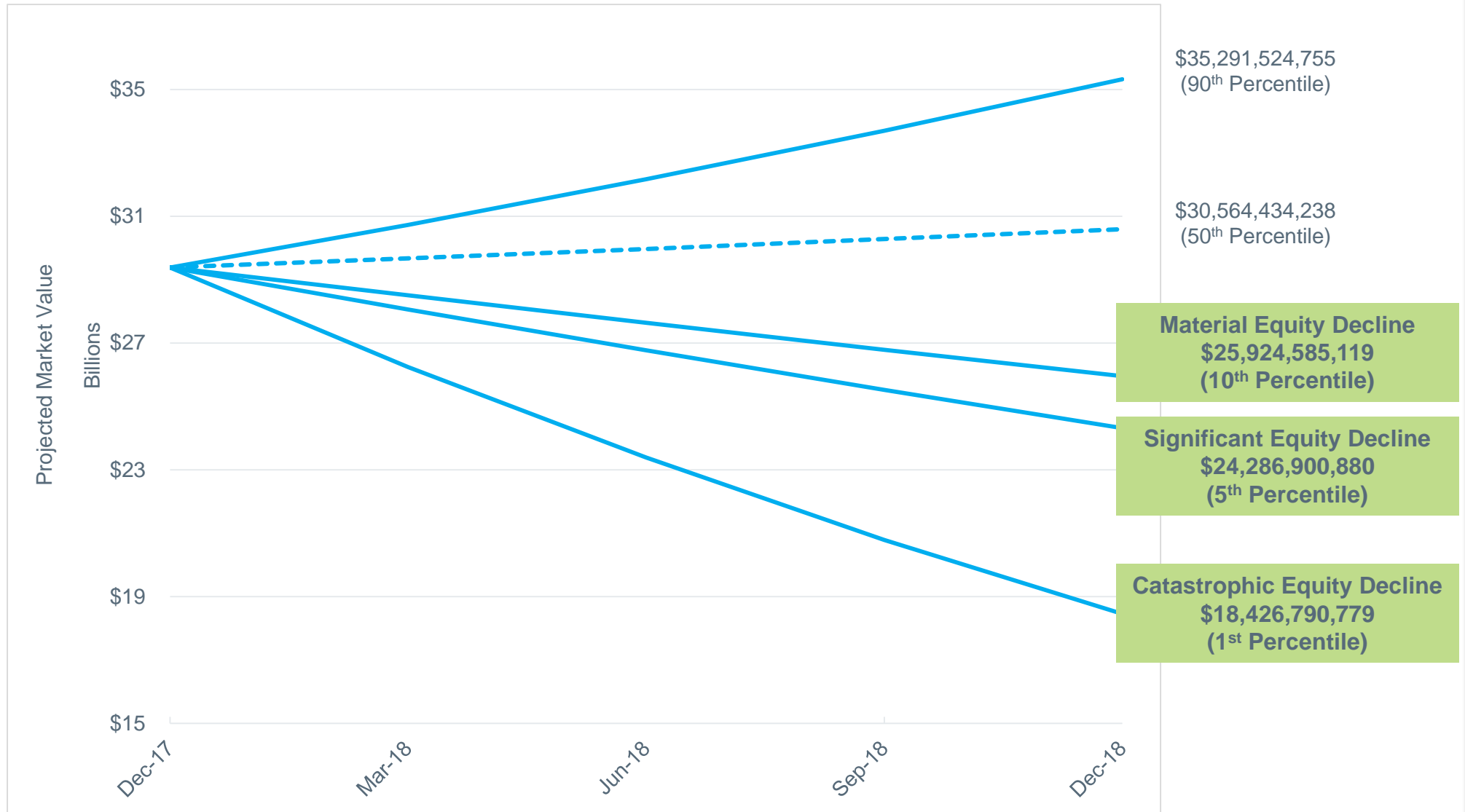
To estimate the possible interactive risk to the fund between downside risk and illiquidity, we select two scenarios defined as follows.

	<i>Material Equity Decline</i>	<i>Significant Equity Decline</i>
SERS Total Fund Decline	12%	17%
SERS Equity Decline	16%	24%
Duration	Twelve months	Twelve months
Benefit Payments	Per the Actuary's Estimate	Per the Actuary's Estimate
Contributions	Per the Actuary's Estimate	Per the Actuary's Estimate
Capital Calls	+20% vs Pacing Studies	+25% vs Pacing Studies
Capital Distributions	-20% vs Pacing Studies	-25% vs Pacing Studies
Administrative Expense	Per current budget	Per current budget

Sequence of Assets Used to Meet Negative Cash Flow in The Following Year

1. Use the Fund's cash allocation
2. Sell fixed income holdings until the ratio of equity to fixed income reaches the pre-equity decline level or the ratio implied in the Board's chosen asset allocation
3. Once the equity/fixed income ratio reaches that point, equity and FI are sold proportionally until negative cash flow deficit has been filled

One Year Downside Loss – Potential Target (Option 2)



Assumes negative quarterly cash flows of \$257,500,000 from the 2018 SERS' Investment Program Cash Flow Forecast.

Material Equity Decline – 10th Percentile Event

A 10th Percentile event over 1 year would result in a Total Fund return of -12% (beta 0.72):

1. Public equity market value	\$12,969,054,919	(-16%)
2. Cash market value	\$948,449,618	(No change)
3. Fixed income market value	\$4,238,194,102	(No change)
4. Net CF deficit	-\$1,592,800,000	+20% Capital Calls -20% Capital Distributions
5. Cash exhausted first	+948,449,618	
6. Maximum amount of Fixed Income available for liquidation*	+\$693,288,892	
Difference between #4, #5 and #6	+\$48,938,510	

Beginning market values are as of 12/31/2017. Cash flows are from the 2018 SERS' Investment Program Cash Flow Forecast totaling -\$1,030,000,000 for 2018. *Fixed Income threshold calculated using the current allocation of Global Public Equity to Fixed Income ratio.

Material Equity Decline and Decreased Contributions

A 10th Percentile event over 1 year and a **25% decrease in employer contributions**:

1. Public equity market value	\$12,969,054,919	(-16%)
2. Cash market value	\$948,449,618	(No change)
3. Fixed income market value	\$4,238,194,102	(No change)
4. Net CF deficit	-\$2,130,800,000	+20% Capital Calls -20% Capital Distributions
5. Cash exhausted first	+948,449,618	-25% Employer Contrib.
6. Maximum amount of Fixed Income available for liquidation*	+\$693,288,892	

Difference between #4, #5 and #6

-\$489,061,490



Equity \$384,079,002

Fixed Income \$104,982,488

Beginning market values are as of 12/31/2017. Cash flows are from the 2018 SERS' Investment Program Cash Flow Forecast totaling -\$1,030,000,000 for 2018. *Fixed Income threshold calculated using the current allocation of Global Public Equity to Fixed Income ratio.

Significant Equity Decline – 5th Percentile Event

A 5th Percentile event over 1 year would result in a Total Fund return of -17% (beta 0.72):

1. Public equity market value	\$11,768,870,298	(-24%)
2. Cash market value	\$948,449,618	(No change)
3. Fixed income market value	\$4,238,194,102	(No change)
4. Net CF deficit	-\$1,733,500,000	+25% Capital Calls -25% Capital Distributions
5. Cash exhausted first	+948,449,618	
6. Maximum amount of Fixed Income available for liquidation*	+\$1,021,342,150	
Difference between #4, #5 and #6	+\$236,291,768	

Beginning market values are as of 12/31/2017. Cash flows are from the 2018 SERS' Investment Program Cash Flow Forecast totaling -\$1,030,000,000 for 2018. *Fixed Income threshold calculated using the current allocation of Global Public Equity to Fixed Income ratio.

Significant Equity Decline and Decreased Contributions

A 5th Percentile event over 1 year and a **25% decrease in employer contributions**:

1. Public equity market value	\$11,768,870,298	(-24%)
2. Cash market value	\$948,449,618	(No change)
3. Fixed income market value	\$4,238,194,102	(No change)
4. Net CF deficit	-\$2,271,500,000	+25% Capital Calls -25% Capital Distributions
5. Cash exhausted first	+948,449,618	-25% Employer Contrib.
6. Maximum amount of Fixed Income available for liquidation*	+\$1,021,342,150	

Difference between #4, #5 and #6

-\$301,708,232



Equity \$236,943,205

Fixed Income \$64,765,028

Beginning market values are as of 12/31/2017. Cash flows are from the 2018 SERS' Investment Program Cash Flow Forecast totaling -\$1,030,000,000 for 2018. *Fixed Income threshold calculated using the current allocation of Global Public Equity to Fixed Income ratio.

Catastrophic Equity Decline – 1st Percentile Event

A 1st Percentile event over 1 year would result in a Total Fund return of -37% (beta 0.72):

1. Public equity market value	\$7,474,260,964	(-52%)
2. Cash market value	\$948,449,618	(No change)
3. Fixed income market value	\$4,238,194,102	(No change)
4. Net CF deficit	-\$2,014,900,000	+35% Capital Calls -35% Capital Distributions
5. Cash exhausted first	+948,449,618	
6. Maximum amount of Fixed Income available for liquidation*	+\$2,195,212,035	
Difference between #4, #5 and #6	+\$1,128,761,653	

Beginning market values are as of 12/31/2017. Cash flows are from the 2018 SERS' Investment Program Cash Flow Forecast totaling -\$1,030,000,000 for 2018. *Fixed Income threshold calculated using the current allocation of Global Public Equity to Fixed Income ratio.

Catastrophic Equity Decline and Decreased Contributions

A 1st Percentile event over 1 year and a **25% decrease in employer contributions**:

1. Public equity market value	\$7,474,260,964	(-52%)
2. Cash market value	\$948,449,618	(No change)
3. Fixed income market value	\$4,238,194,102	(No change)
4. Net CF deficit	-\$2,552,900,000	+35% Capital Calls -35% Capital Distributions
5. Cash exhausted first	+948,449,618	-25% Employer Contrib.
6. Maximum amount of Fixed Income available for liquidation*	+\$2,195,212,035	
Difference between #4, #5 and #6	+\$590,761,652	

Beginning market values are as of 12/31/2017. Cash flows are from the 2018 SERS' Investment Program Cash Flow Forecast totaling -\$1,030,000,000 for 2018. *Fixed Income threshold calculated using the current allocation of Global Public Equity to Fixed Income ratio.

Material Equity Decline – 10th Percentile Event

A 10th Percentile event over 1 year would result in the following ratios after cash flows:

Metric	Before Event	After Event	Change
Total Fund	\$ 29,385,572,826	\$ 24,331,785,119	\$ (5,053,787,708)
Illiquids	\$ 8,693,473,018	\$ 7,768,886,480	\$ (924,586,538)
Liquid/Total Fund	70%	68%	-2%
Liquid/Illiquid	2.38	2.13	-0.25
Cash/Total Fund	3%	0%	-3%
Net Benefits/Total Fund	3%	4%	1%
Net Benefits/Liquid	5%	6%	1%
Cash/Net Benefits	97%	0%	-97%

Annual benefit payments are \$974,000,000 (net of employer and employee contributions) and from the 2018 SERS' Investment Program Cash Flow Forecast.

Significant Equity Decline – 5th Percentile Event

A 5th Percentile event over 1 year would result in the following ratios after cash flows:

Metric	Before Event	After Event	Change
Total Fund	\$ 29,385,572,826	\$ 22,553,400,880	\$ (6,832,171,946)
Illiquids	\$ 8,693,473,018	\$ 7,331,386,862	\$ (1,362,086,157)
Liquid/Total Fund	70%	67%	-3%
Liquid/Illiquid	2.38	2.08	-0.30
Cash/Total Fund	3%	0%	-3%
Net Benefits/Total Fund	3%	4%	1%
Net Benefits/Liquid	5%	6%	2%
Cash/Net Benefits	97%	0%	-97%

Annual benefit payments are \$974,000,000 (net of employer and employee contributions) and from the 2018 SERS' Investment Program Cash Flow Forecast.

Catastrophic Equity Decline – 1st Percentile Event

A 1st Percentile event over 1 year would result in the following ratios after cash flows:

Metric	Before Event	After Event	Change
Total Fund	\$ 29,385,572,826	\$ 16,411,890,779	\$ (12,973,682,047)
Illiquids	\$ 8,693,473,018	\$ 5,765,886,094	\$ (2,927,586,924)
Liquid/Total Fund	70%	65%	-6%
Liquid/Illiquid	2.38	1.85	-0.53
Cash/Total Fund	3%	0%	-3%
Net Benefits/Total Fund	3%	6%	3%
Net Benefits/Liquid	5%	9%	4%
Cash/Net Benefits	97%	0%	-97%

Annual benefit payments are \$974,000,000 (net of employer and employee contributions) and from the 2018 SERS' Investment Program Cash Flow Forecast.

Appendix



Memorandum

To	Commonwealth of Pennsylvania State Employees' Retirement System
From	RVK, Inc.
Subject	Asset/Liability Study – Executive Summary DRAFT
Date	August 24, 2015

Introduction

The purpose of this memorandum is to summarize the key inferences we draw from the Asset/Liability (“A/L”) study of the Commonwealth of Pennsylvania State Employees’ Retirement System (“SERS” or the “Plan”). While this memorandum refers directly to points raised within the study, we emphasize that a full understanding of the A/L study and its implications requires a close review of the study in its entirety.

Background and Key Conclusions

As of the fiscal year beginning December 31, 2014, the date of the most recent actuarial valuation and the start date of the projections in this study, the Plan was 61% funded (on a market value basis) meaning that assets were available to cover 61% of Plan liabilities as currently estimated by the Plan’s actuary. This equates to a shortfall of approximately \$17.4 billion. This is a significant concern for the future of the Plan’s financial health, however, this study shows that the Plan remains solvent and while the Plan’s funding ratio will fluctuate during this period, the study suggests the potential for reducing the funding gap over the next 20 years.

As highlighted below, this study suggests that continued diversification in the investment of Plan assets is desirable. The study, however, suggests caution in assuming that increased pursuit of higher expected returns, through even more aggressive (and hence even more volatile) asset allocations, is always beneficial. High expected return and high expected risk approaches bring with them increased risk of large declines in the value of the Plan and increased volatility in required contributions.

The Purpose of an Asset Liability Study

The central purpose of an A/L study is to examine the probable future consequences, over extended periods of time, of applying alternative asset allocation strategies to the Plan’s investment assets in order to fund the liabilities created by the benefit provisions of the Plan. A/L studies are unique in their ability to combine in a single analysis the three critical factors that drive the financial health of the Plan—benefit policy (liabilities), contribution policy, and investment strategy (asset allocation). Certainly this type of forward looking study—nor any others we are aware of—cannot indicate with any reliability what will happen in any given year over this extended period of time and its insights are dependent on the assumptions used. However, we have high conviction that the study’s results paint a highly reliable view of the core long-term trends in the Plan’s financial health. Best practice, in our judgment, is to take the general direction

suggested as most appropriate by this study with its unique consideration of liabilities, contribution policy and trending liquidity needs and refine it in an asset allocation study. At that point, implementation of the Plan's structure can reflect the pragmatic considerations of investing in the capital markets present at any given point in time.

Deterministic versus Stochastic

In this study, we examined a series of related questions associated with this central purpose, projecting future outcomes under two distinctly different methodologies:

1. a **deterministic** basis (all underlying assumptions, liabilities, contributions and most critically investment returns, are achieved precisely and without variance in each and every year); and
2. a **stochastic** basis (outcomes for investment returns vary each year according to estimated volatility with contribution *requirements* following suit while *actual* contribution policy and liabilities remains in their current form).

Key Results

Below you will find a series of important findings, forecasts, and conclusions drawn from the body of the study. While the remarks are presented here to allow a quick assessment of some of the key findings, they represent only a sampling of the fundamental elements of the study. We emphasize that a solid understanding of each element requires that they be reviewed as they are presented in the study itself within their surrounding context (please note the frequent page references to the full study). This is especially important to understanding the findings which represent *probable, but not certain*, outcomes as analyzed in the stochastic section of the study.

At the Outset:

- As of December 31, 2014 (the date of the actuarial valuation used to model liabilities), the Plan's market value funded ratio (available assets to fund benefit obligations) was 61% (page 6).
- The number of inactive members currently exceeds the number of active members by approximately 1.2 to 1.0. This relationship of inactive (non-contributing and, in the case of retirees, benefit drawing) members to active (contributing) members is expected to remain in place going forward (page 8). The mature demographics of the Plan are an important factor when considering the findings on Plan risk/return options and the projected status of Plan liquidity below.

Deterministic Analysis: A deterministic analysis assumes full certainty about the future, in particular, certainty of investment returns. Its virtues are that it is simple and that the findings reflect what will happen if the future turns out to be precisely as forecasted—no better, but also no worse.

- Benefit payments to Plan participants are expected to increase by 64% over the next 20 years (page 9). Annual increases are projected to range between 0% and 5%.
- Total employer annual dollar contributions are expected to increase through the projection period by approximately 90% (page 10). *Please note however*, that precise actuarially required rates as they unfold are the purview of the Plan's actuary and are affected by factors other than investment returns and resulting asset values of the Plan.
- Contributions expressed as a weighted average percentage of salary are projected to gradually decline after a 4.5% increase in the first year of the projection period (page 11). The large increase in 2016 is a result of the current contribution policy in place as mandated by Act 2010-120. The Act limits increases in employer contribution rates to 4.5% per year until the Annual Required Contribution ("ARC") is reached. We project contribution rates under the Act will reach the ARC in 2016.
- Aggregate benefit payments are expected to increase by about 64% over the next 20 years but actually gradually decrease as a percentage of Plan assets (payout ratio) over this same time period (pages 9 and 13). Payout ratios are projected to remain healthy during the projection period. This is an important and positive indication, because sustained increases in payout ratios can continue to impose liquidity constraints on the management of the portfolio (inhibiting the ability of the Plan to invest with a long-term horizon) therefore limiting the opportunity to invest in less liquid asset classes regardless of the return or risk reducing diversification benefits they may offer. The payout ratio is projected to gradually fall from about 11% today to about 7% at the end of the projection period. These levels do not, in our opinion, materially inhibit investment opportunities for the Plan (page 13).
- As assets grow each and every year without exception at the assumed rate of return (7.50%), the funding ratio on a market value basis is expected to gradually increase to approximately 80% by 2034 from the current value of 61% (page 18).
- Assuming the current contribution policy remains unchanged, the Plan would need to experience annual returns in excess of 12% over the next 10 years or 9% over the next 20 years without exception in each and every year in order to reach full funding (page 19). Achieving such lofty returns on such a sustained basis is extremely unlikely in our judgment and underscores our conclusion that investment returns alone cannot move the Plan to full funding.
- Experiencing a return of 100 basis points below the Plan's current assumed rate of return of 7.50% (i.e., 6.50%) each year for the 20 year projection period would result in a material decline in the projected funding ratio to 70% in year 20 versus 80% assuming the assumed rate of return is met each year (page 20). Additionally, this would require an additional \$5.2 billion in contributions over the next 20 years under. Given the widely shared concerns by some about the prospects for a low return environment in the capital markets

over the foreseeable future, this is a conclusion that should be thoroughly understood and appreciated. In the event that capital markets do not support returns commensurate with the assumed rate of return, reliance on contributions to complete the payout of the Plan's liabilities effectively increases, especially in later years.

- Should employer contributions remain at current levels (25% of salary), the Plan would end the projection period with a funding ratio of 66%, materially lower than under the contribution rates mandated by Act-120 (page 21).

Stochastic Analysis: Unlike a deterministic analysis, a stochastic analysis does not assume an unvarying stream of expected investment returns year after year. Instead, it reflects the realistic view that pension plan investment returns are—like the investment markets themselves—volatile and always uncertain. This means that there are a range of possible outcomes for the Plan; some are more likely, others less likely, but still possible.

The deterministic approach is useful for gauging the general direction of change and associated consequences, but adding the element of uncertainty—more specifically year to year variability in the performance of the capital markets and the value of the Plan's assets over time—can offer additional insights, albeit along with considerable complexity.

Uncertainty in future investment returns is taken into account via a stochastic analysis of five different investment approaches (in the table below and on page 27) ranging from highly conservative (low risk, asset protective) to highly aggressive (high return seeking with substantial associated risk), including the current Target Allocation of the Plan. The reason for testing such a broad range of approaches is that at the heart of the Plan's situation is a simple question that is difficult to answer: whether the Plan is better off following a strategy that:

- (A) Falls in the general category of higher prospective return with greater risk (i.e. potential for more widely varying outcomes – good or bad), or
- (B) Falls in the general category of lower prospective return with concomitantly lower risk (i.e. a tighter band of likely outcomes).

	Min	Max	1	2	3	4	5	6	7	8	9	10	Curr	Cons	1	2	3	4	Aggr
Global Equity	25	45	27	25	25	25	27	29	32	34	36	45	39	0	30	38	40	42	75
SERS Custom Fixed Income	10	25	25	25	23	22	20	18	15	13	11	10	18	100	40	26	20	14	0
Long-Biased L/S Equity	5	15	15	15	15	15	15	15	15	15	15	7	8	0	10	8	9	10	0
Private Equity	15	20	15	17	19	20	20	20	20	20	20	20	19	0	10	14	16	18	25
SERS Custom Real Estate	10	15	15	15	15	15	15	15	15	15	15	15	11	0	10	11	12	13	0
Cash Equivalents	3	3	3	3	3	3	3	3	3	3	3	3	5	0	0	3	3	3	0
Total			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Capital Appreciation			52	52	53	54	56	57	59	61	62	71	65	25	52	61	64	66	100
Capital Preservation			20	19	19	18	16	15	13	12	10	10	17	67	27	20	16	12	0
Alpha			15	15	15	15	15	15	15	15	15	7	8	0	10	8	9	10	0
Inflation			14	14	13	13	13	13	13	13	12	12	10	8	11	11	11	11	0
Expected Return			6.98	7.06	7.14	7.22	7.30	7.39	7.47	7.55	7.63	7.71	7.31	4.13	6.51	6.97	7.24	7.50	8.47
Risk (Standard Deviation)			12.06	12.27	12.54	12.81	13.13	13.46	13.79	14.12	14.45	15.12	13.81	6.66	10.88	12.61	13.47	14.35	19.27
Return (Compound)			6.31	6.36	6.41	6.46	6.51	6.56	6.60	6.63	6.67	6.66	6.43	3.92	5.96	6.23	6.40	6.55	6.80
Return/Risk Ratio			0.58	0.58	0.57	0.56	0.56	0.55	0.54	0.53	0.53	0.51	0.53	0.62	0.60	0.55	0.54	0.52	0.44
RVK Expected Eq Beta			0.59	0.60	0.61	0.62	0.64	0.66	0.68	0.70	0.72	0.76	0.69	0.12	0.54	0.63	0.68	0.72	0.99
RVK Liquidity Metric			57	55	54	53	53	53	54	54	54	59	61	77	65	64	62	60	69

Essential to answering this question is to ask precisely how the Plan and its broader constituencies define what “better off” means. The metrics we use for each to determine whether the Plan is “better off” under one approach versus another are as follows:

- (1) The effect on funding ratio (and thus on contribution rates which decline with higher funding ratios).
- (2) The effect on Plan liquidity (i.e. the Plan’s ability to pay annual benefits without major disruption of its strategic asset allocation, the driver of its investment strategy).
- (3) The effect on the trend line and stability of annual contributions.
- (4) The risk of large, sudden, and highly disruptive short-term declines in the Plan’s assets over the course of time and the associated effects on contributions and potentially investment decisions.

The results of this analysis are displayed on pages 28 through 50 of the accompanying A/L study. For purposes of this summary, the consequences of choosing A versus B, as described above, is summarized most clearly in the tables on pages 34 and 50 of the study (copied below followed by explanatory comments).

20 Years	Probability of Full Funding in 2034	Probability of < 61% (Current) Funding in 2034	Probability of < 50% Funding in 2034	Maximum 1 Year Investment Loss
Current Allocation	19%	39%	20%	-36%
Conservative Portfolio	0%	82%	42%	-25%
Portfolio 1	10%	43%	19%	-29%
Portfolio 2	16%	40%	20%	-33%
Portfolio 3	18%	39%	20%	-35%
Portfolio 4	21%	37%	20%	-37%
Aggressive Portfolio	29%	37%	23%	-48%

20 Years	Market Funded Ratio in Year 20			Cumulative Employer Contributions in Year 20 (Billions)			Payout Ratios		
	50th	5th	95th	50th	5th	95th	Year 20	Years 1 to 20	
							Median	Peak	Trough
Current Allocation	69%	38%	153%	\$53.1	\$72.7	\$18.9	9%	21%	4%
Conservative Portfolio	52%	39%	70%	\$64.1	\$74.9	\$52.6	11%	20%	8%
Portfolio 1	65%	41%	116%	\$55.8	\$71.6	\$27.8	9%	20%	5%
Portfolio 2	67%	39%	136%	\$54.1	\$72.3	\$22.4	9%	20%	4%
Portfolio 3	68%	38%	149%	\$53.1	\$72.5	\$20.0	9%	21%	4%
Portfolio 4	70%	38%	162%	\$53.1	\$72.5	\$20.0	9%	21%	4%
Aggressive Portfolio	72%	33%	242%	\$50.4	\$76.6	\$11.7	8%	25%	2%

- With the exception of the Conservative Portfolio, each of the portfolios result in median expected funding ratios at the end of the 20 year study period that are higher than the current funding level (61%) (pages 33 and 50). In general, as you incrementally increase the expected risk and return of the fund (from Portfolio 1 to I Portfolio 4), the outcomes appear to gradually improve at the cost of slightly reduced worst-case outcomes. This is supportive of the continued utilization of diversified investment approach.
- The probability of ending the projection period with a lower funded ratio than the current level ranges from 82% for the Conservative Portfolio to 37% for Portfolio 4 and the Aggressive Portfolio (page 34). Conversely, the probability of ending the projection period with a materially lower funded ratio than the current level (defined as below 50%) is 42% for the conservative portfolio and near 20% for each of the other portfolios.
- The probability of reaching full funding at the end of the projection period varies with each portfolio ranging from 0% for the Conservative Portfolio to 29% for the Aggressive Portfolio (page 34). The diversified portfolios (including the Current Allocation) show a probabilities between 10% and 21%.
- None of the portfolios show extreme median payout ratios over the next 20 years (pages 35-41 and 50). Peak payout ratios range between 20% and 25%. While these levels are unlikely, they would begin to inhibit asset allocation decisions as they relate to illiquid asset classes. As a result, Plan liquidity needs should continue to be monitored closely.
- The cumulative cost of providing the Plan’s benefits is met through a combination of contributions and the investment returns on those contributions. The Conservative Portfolio will require the largest future increase in contributions (i.e., the direct funding of benefits) (pages 43, 49, and 50). Even under the very unlikely best-case scenario the Plan would have a funded ratio of about 52%, far lower than any of the other portfolios and lower than the current value (pages 33 and 50). The only redeeming virtue of such an ultra-conservative approach is that the potential for large declines in the value of the fund is significantly mitigated albeit at much higher ongoing costs (contributions) and chronic poor Plan financial health.
- The Aggressive Portfolio does appear to have the highest *probability* of producing full funding by 2035 at 29% (page 34). *However*, it also has a maximum theoretical one-year

portfolio decline of 48%—a loss of almost one half of the Plan’s assets, significant we believe by any standard. This likelihood of notably larger one year declines within the study period gives pause to the desirability of a far more aggressive approach simply from a quantitative viewpoint. It also suggests it may be a strategy that is extremely difficult for decision makers to sustain over a long period of time. Declines in the total fund market value of this magnitude are a disruptive event from all aspects of Plan management. Yet, the benefit of such an aggressive approach that makes it superficially attractive can only be realized with any probability if the aggressive and highly volatile approach is maintained for several decades through good times, bad times, and unnerving times. Furthermore, this type of strategy could prove difficult to maintain in future years should demographic (early retirement incentives for example) or financial events create higher liquidity demands on the Plan. For all these reasons, it is not an approach that should be seriously considered without full recognition of the significant risks.

- While RVK supports the conclusions of the study using our current capital market assumptions, we also model for extreme market scenarios to stress test the results of the study. The summary of this analysis can be found in Appendices 1 and 2 (beginning on pages 51 and 54 respectively). The first test models the case of extreme market volatility by doubling the assumed standard deviations of all asset classes. The second test models converging market returns by assuming all assets are perfectly correlated (i.e. correlations equal +1.00). The results of these additional analyses show that the *relative* portfolio outcomes do not change, but that the range of potential results widens, indicating higher risk for all asset mixes given the increased systemic volatility and the reduced dampening effects of total fund diversification we assume under these stress scenarios.

Final Comments

This A/L study shows that the Plan is currently underfunded but improvements in financial health are possible. The Plan can best meet its objectives through the continued use of a well-diversified investment portfolio. **However, positive outcomes are extremely dependent on the contribution policy.** The study is not supportive of a long-term, ultra-conservative approach. The increasing potential for large one-year declines suggests that there is likely a limit to the net benefits of adding increased risk in pursuit of additional return. Progress should be monitored periodically through studies such as these, particularly if the Plan encounters a sustained period of lower returns in the capital markets (and thus for the Plan’s assets) as well as material changes in contribution policy or benefit levels.

Additionally, this study assumes no further changes are made to the benefit policy at any point during the 20 year projection period. Such changes would fall outside the reach of an Asset/Liability study. However, we do note that even small changes to the benefit policy can have a meaningful long-term impact on the likely future outcomes of the Plan.

September 2015

Asset/Liability Study

Commonwealth of Pennsylvania State Employees'
Retirement System



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Introduction

RVK, Inc. (RVK) has prepared this report for the Commonwealth of Pennsylvania State Employees' Retirement System (SERS) to:

- Present projected valuation results with respect to the funded status of the Plan.
- Present projected benefit payments of the Plan.
- Investigate asset mixes to determine those which best serve to protect and increase funding levels, while providing adequate liquidity for benefit payments.

The valuation projections are shown using both a deterministic and stochastic process.

The deterministic process provides an open group analysis of projected valuation results based on a fixed set of future assumptions (see summary in the Assumptions and Methods section of this report).

The stochastic process provides an open group analysis of projected valuation results under many capital market environments based on expected asset returns and inflation, and their expected volatility. Using a Monte Carlo simulation technique, both assets and liabilities are assumed to vary stochastically, linked together by changes in inflation. Expected values, variances of the returns and inflation, and correlations are used to generate 2,000 trials to produce a distribution of potential outcomes. A stochastic analysis can answer questions about the best/worst case outcomes along with the probability of such outcomes.

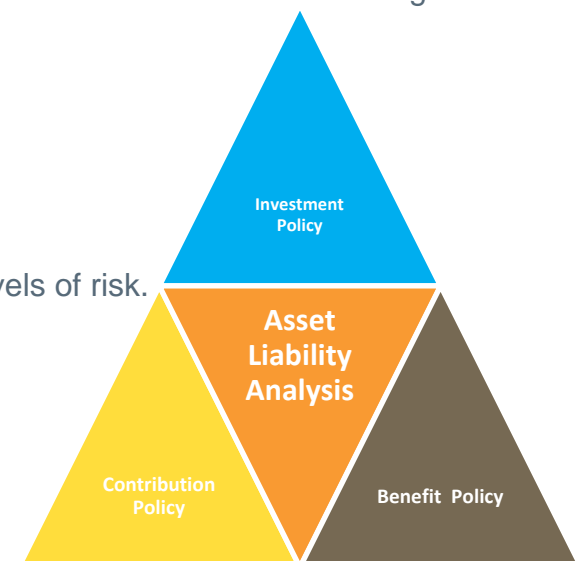
Introduction (continued)

What is an Asset/Liability Study?

- Investment programs and the strategy they seek to implement (Investment Policy) do not exist in a vacuum. They seek to satisfy one or more investment objectives and operate within a plan framework that includes the investment objectives (Benefit Policy) and plan funding (Contribution Policy).
- The purpose of an Asset/Liability Study is to examine how well alternative investment strategies (i.e., differing asset allocations) address the objectives served by the Plan—the Plan's "liabilities" in the context of the Plan's funding streams—the Plan's Contribution Policy. It is the only standard analysis that fully links all three aspects of the Plan's key financial drivers.
- In doing so, it creates an important "guidepost" for the actual asset allocation for the Plan; the asset allocation chosen by the Plan's fiduciaries will likely reflect the nature of the liabilities but also numerous other factors including risk preferences, liquidity, implementation constraints, etc.
- For the SERS Asset/Liability Study, we assume the objectives are:
 1. Fund all participants' benefits over time.
 2. Assure sufficient liquidity to pay benefits at all times.
 3. Foster a stable contribution stream consistent with objectives 1 and 2.
 4. Achieve adequate returns without accepting unnecessary or imprudent levels of risk.

An Asset/Liability Study is NOT . . .

- An actuarial study of the SERS liabilities—that is the purview of the Plan's actuary.
- A prescription for Plan benefits—that is the purview of the elected representatives.
- An assessment of the affordability of contribution levels—that is the purview of the elected officials and their constituents.
- The sole determinant of the final asset allocation adopted for the Plan—there are a number of factors, including insights from an Asset/Liability Study, which will bear on the optimal asset allocation.



Introduction (continued)

Asset/Liability Studies in Practice . . .

- Begin with a forecast of the financial liabilities (i.e., benefit obligations).
- Include a baseline estimation of the financial contributions to the Plan over time.
- Compare alternative investment strategies (i.e., total fund asset allocations to the Plan's financial needs).
- Draw conclusions regarding how well various investment strategies satisfy the Plan's financial needs.

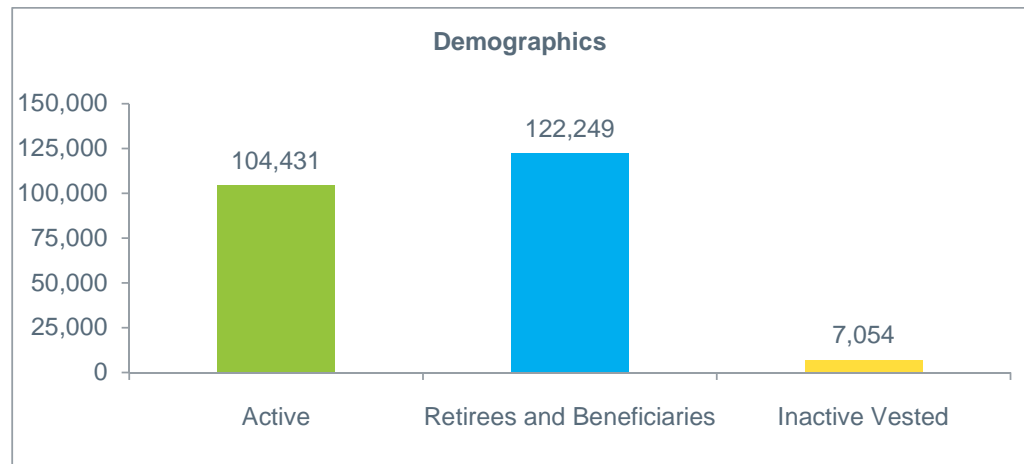
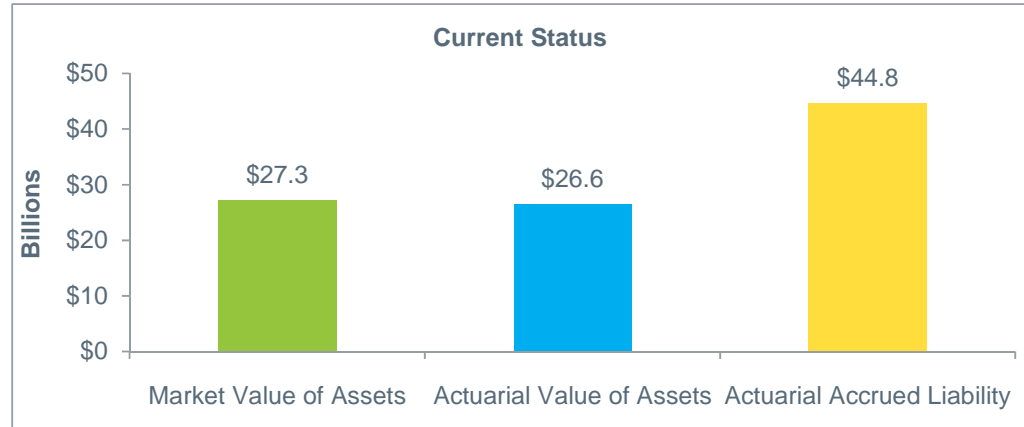
This Asset/Liability Study . . .

- Uses data from the December 31, 2014 SERS Actuarial Valuation provided by the Hay Group to project pension liabilities.
- Uses the actuarial cost method and the actuarial assumptions described in the December 31, 2014 SERS Actuarial Valuation prepared by the Hay Group.
- Compares these specific investment strategies—(A) the Current Allocation, (B) a conservative illustrative portfolio (Conservative Portfolio), (C) a range of diversified portfolios (Portfolios 1, 2, 3, and 4), and (D) an aggressive illustrative portfolio (Aggressive Portfolio).
- Assumes the Plan's current benefit policy throughout the entire projection period—changes to the benefit policy are the purview of the elected representatives.
- Note: Does not assume any actuarial adjustments that may take place in future years.

Current Status

A summary of the Plan follows:

Valuation Date	December 31, 2014
Market Value of Assets (MVA)	\$27.3 billion
Actuarial Value of Assets (AVA)	\$26.6 billion
Actuarial Accrued Liability (AAL)	\$44.8 billion
Market Value Funded Ratio (MVA/AAL)	61%
Actuarial Value Funded Ratio (AVA/AAL)	59%
Active	104,431
Retirees and Beneficiaries	122,249
Inactive Vested	7,054



Deterministic Analysis

This section provides an analysis of the Plan's assets, liabilities, funded status, and benefit payments based on a fixed set of future assumptions. Each analysis that follows in this deterministic section rests on the critical assumptions below and must be read and interpreted with them in mind—particularly assumptions #2, #3 and #4.

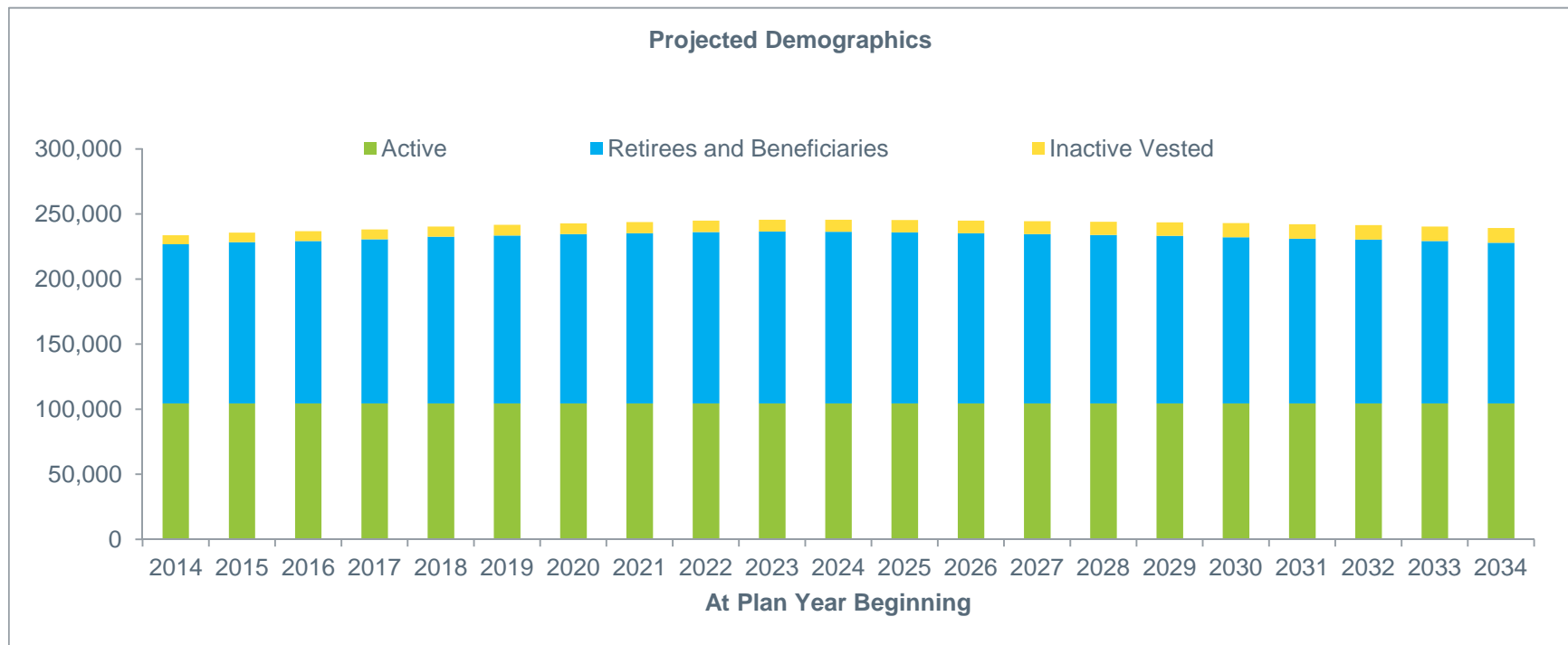
The deterministic assumptions are as follows:

1. Current Plan provisions (see Summary of Benefit and Contribution Provisions beginning on page 43 of the December 31, 2014 actuarial valuation prepared by the Hay Group.)
2. The participant data used in the December 31, 2014 actuarial valuation prepared by the Hay Group.
3. Actuarially assumed rate of return on Plan assets for all projection years: 7.50%.
4. Assumes total employer contributions equal to (1) gross normal cost, less expected employee contributions, plus (2) a level dollar amortization of unfunded actuarial liability. Employer contributions were adjusted by contribution collars provided by Act 2010-120, if applicable.
5. Assumes demographic experience projected in accordance with the assumptions used in the December 31, 2014 actuarial valuation prepared by the Hay Group.
6. Open group analysis: level active population. New active participants entering the Plan are assumed to have similar characteristics to recently hired participants.

Deterministic Analysis (continued)

Demographics

Following are the projected number of active and inactive participants at the beginning of each Plan year from 2014 through 2034 (2014 is actual). These projections are based on an open group analysis. Using the actuary's assumptions for death, termination, retirement, and disability, current participants are assumed to leave the Plan in the future. The number of total inactive participants (Retirees and Beneficiaries and Vested Inactive) increases by approximately 4% during the 20-year projection period shown.

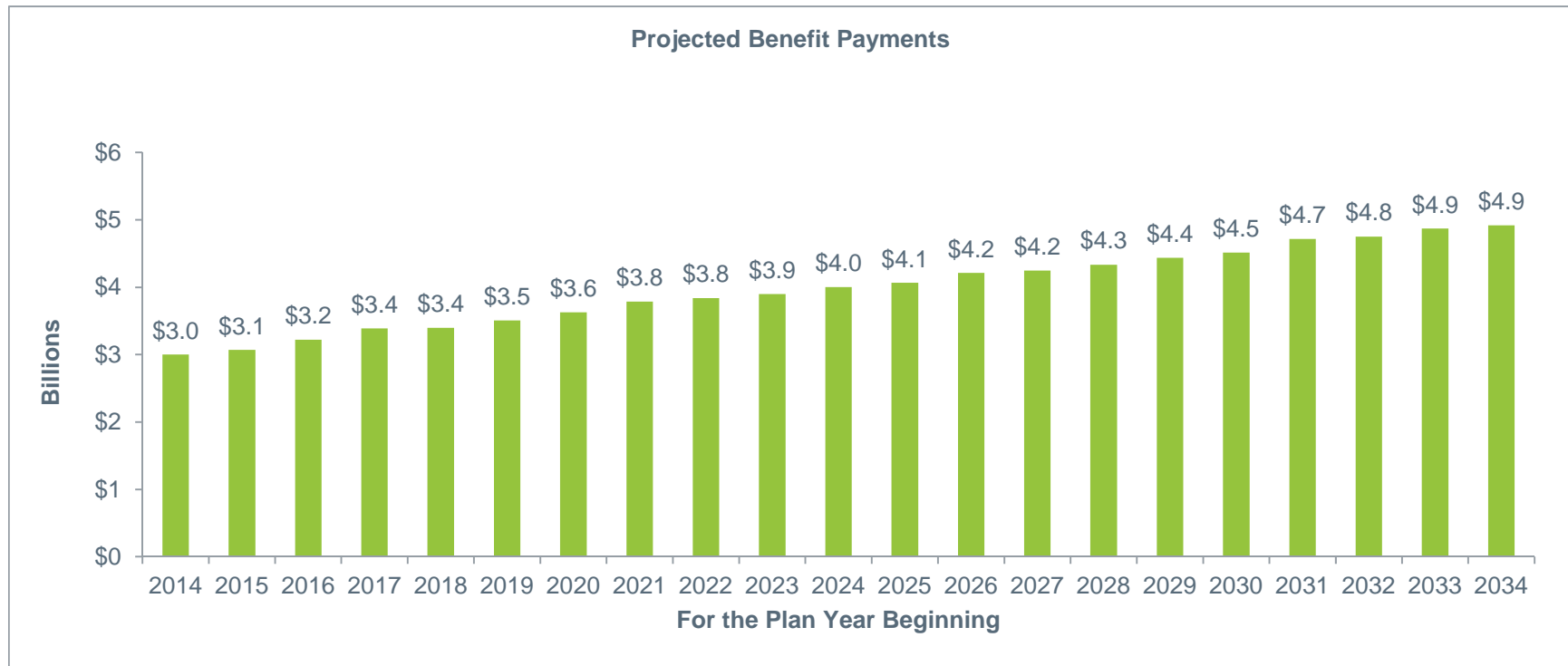


Total Population	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Annual Percent Change	N/A	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Deterministic Analysis (continued)

Benefit Payments

The Plan's projected annual benefit payments are shown in the chart below. The projected benefit payments are expected to increase by about 64% over the next 20 years. As a percentage of the market value of Plan assets, benefit payments are expected to gradually decline through the end of the projection period (see page 13).

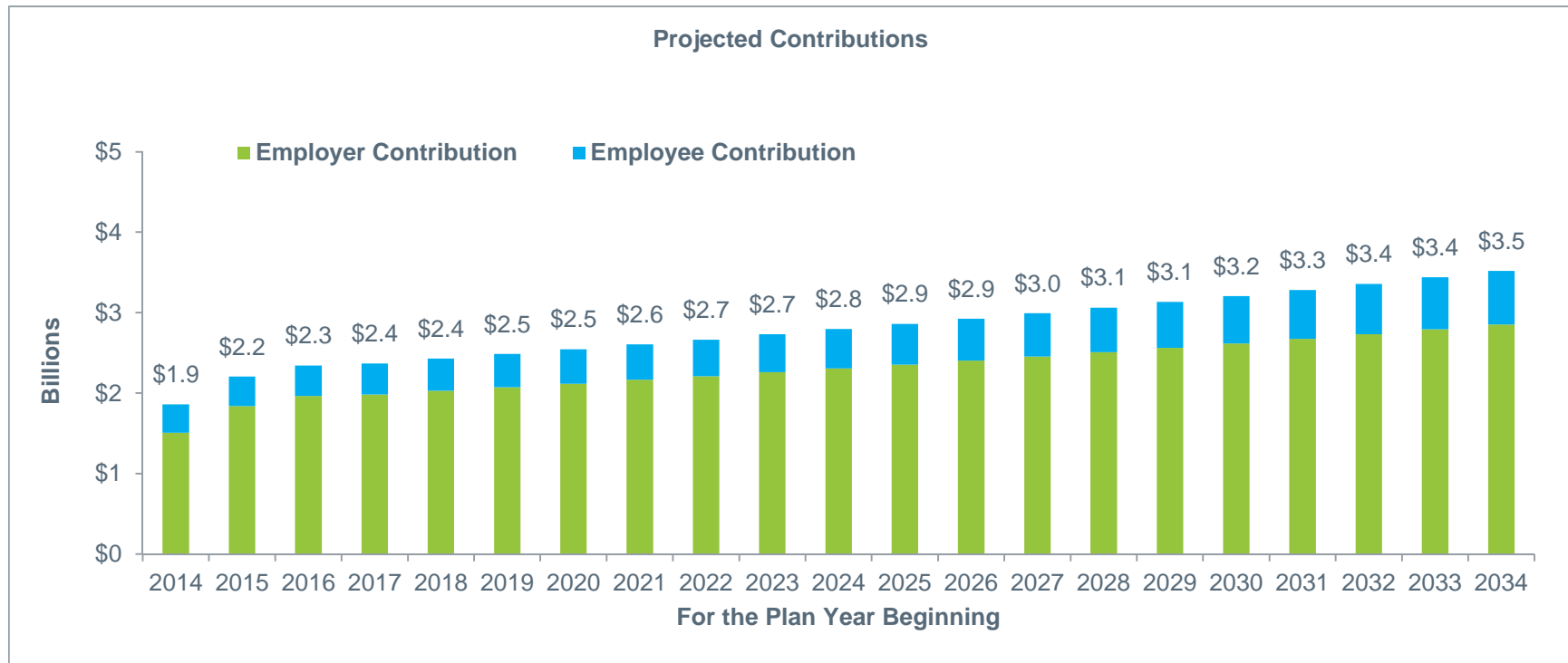


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Annual Percent Change	N/A	2%	5%	5%	0%	3%	3%	4%	1%	2%	3%	2%	4%	1%	2%	2%	2%	5%	1%	2%	1%

Deterministic Analysis (continued)

Contributions

The Plan's projected contributions, expressed as total dollar contributions, are shown in the chart below. The results assume the contribution policy remains unchanged, and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years.

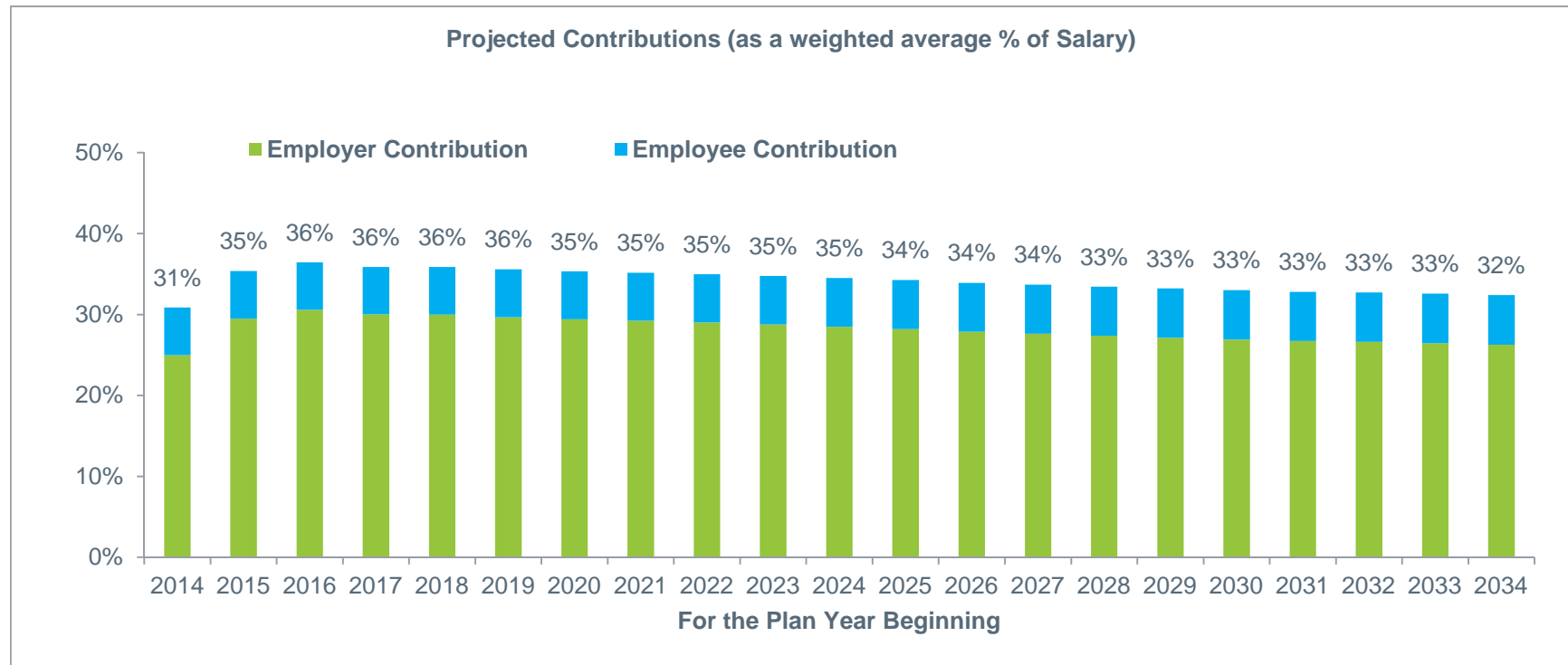


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Annual Percent Change	N/A	19%	6%	1%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%

Deterministic Analysis (continued)

Contributions

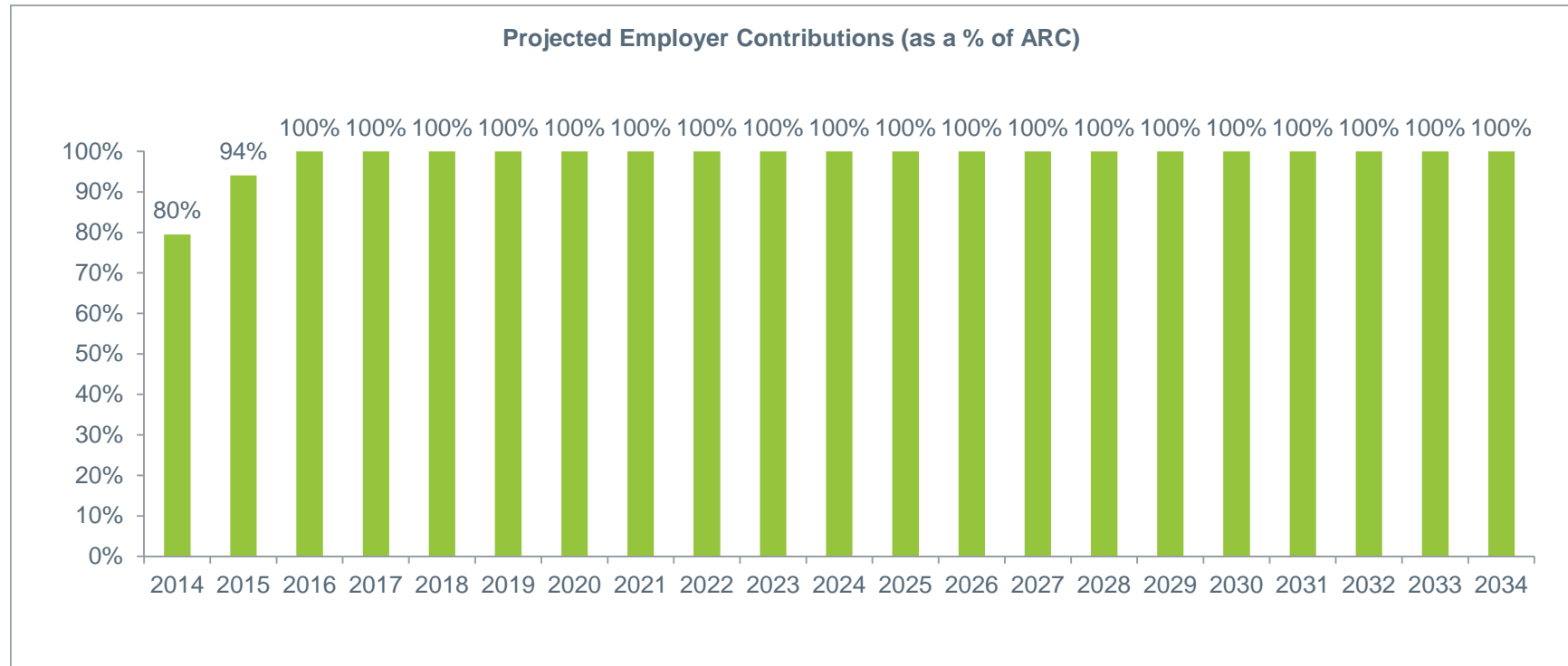
The Plan's projected contributions, expressed as a weighted average percentage of salary, are shown in the chart below. The results assume the contribution policy remains unchanged, and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years.



Deterministic Analysis (continued)

Contributions

The Plan's projected employer contributions, expressed as a percentage of the Annual Required Contribution (ARC)*, are shown below. ARC is calculated using a 30 year declining amortization period. Increases in employer contributions are capped by Act 2010-120 leading to contributions in the early years that are lower than ARC. The results assume current contribution rates for employees and employers.



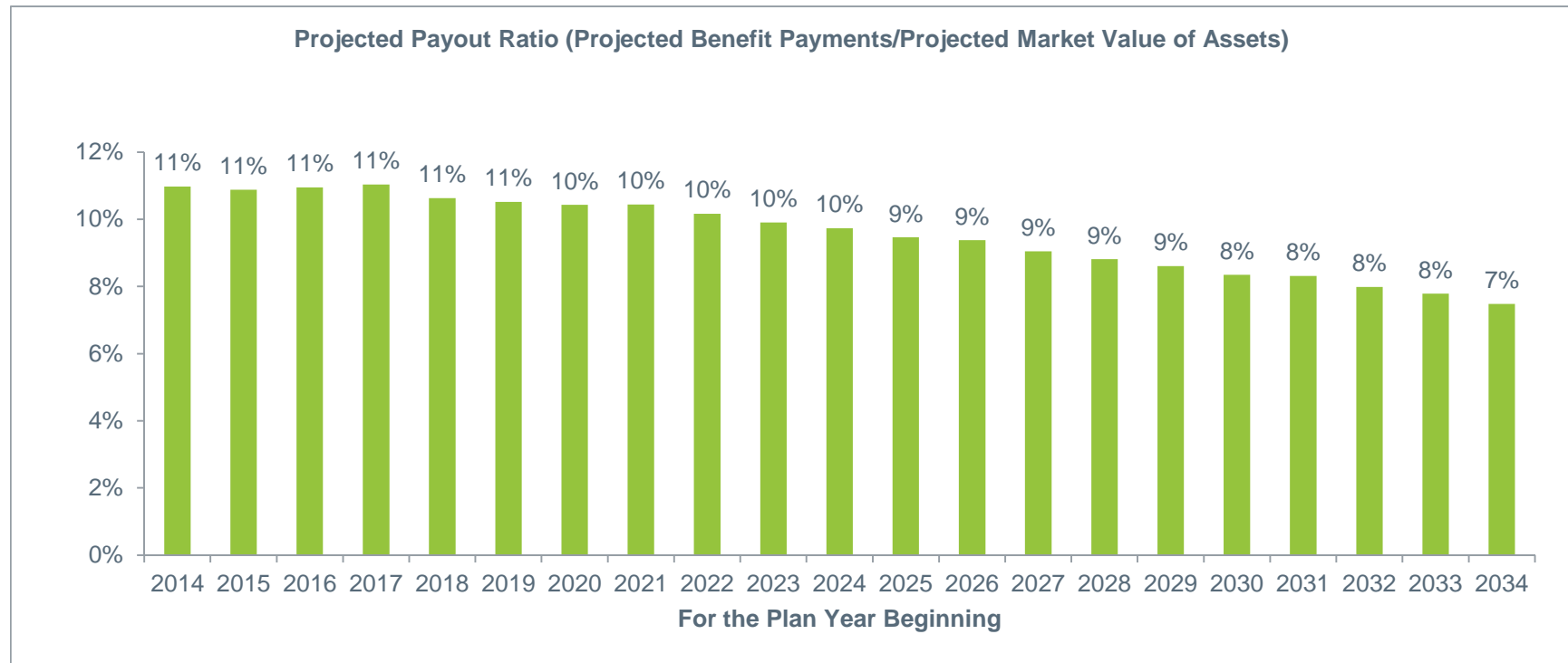
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Projected Employer Contribution	25.0%	29.5%	30.6%	30.0%	30.0%	29.7%	29.4%	29.2%	29.0%	28.8%	28.5%	28.2%	27.9%	27.6%	27.4%	27.1%	26.9%	26.7%	26.6%	26.5%	26.3%
Projected ARC	31.4%	31.4%	30.6%	30.0%	30.0%	29.7%	29.4%	29.2%	29.0%	28.8%	28.5%	28.2%	27.9%	27.6%	27.4%	27.1%	26.9%	26.7%	26.6%	26.5%	26.3%
Absolute Change in EC	4.5%	4.5%	1.1%	-0.6%	-0.1%	-0.3%	-0.3%	-0.2%	-0.2%	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	-0.2%	-0.2%	-0.2%	-0.2%	-0.1%	-0.2%	-0.2%

*ARC excludes employee contributions. Employee contributions are assumed to be contributed in full each year.

Deterministic Analysis (continued)

Payout Ratio (benefit payments/market value of assets)

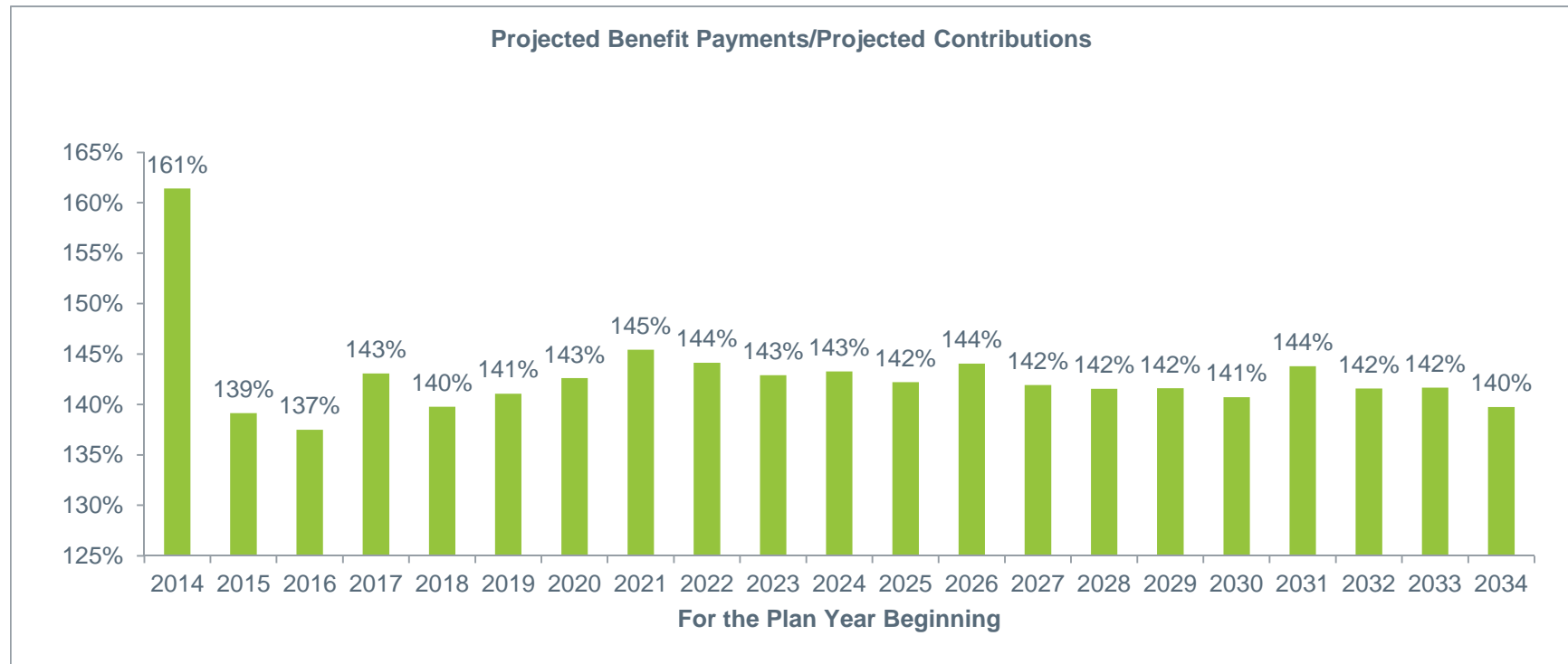
The Plan's projected payout ratios are shown in the chart below. The payout ratio is expected to gradually decline through the end of the projection period. The results assume the current contribution policy remains unchanged and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years.



Deterministic Analysis (continued)

Benefit Payments/Contributions

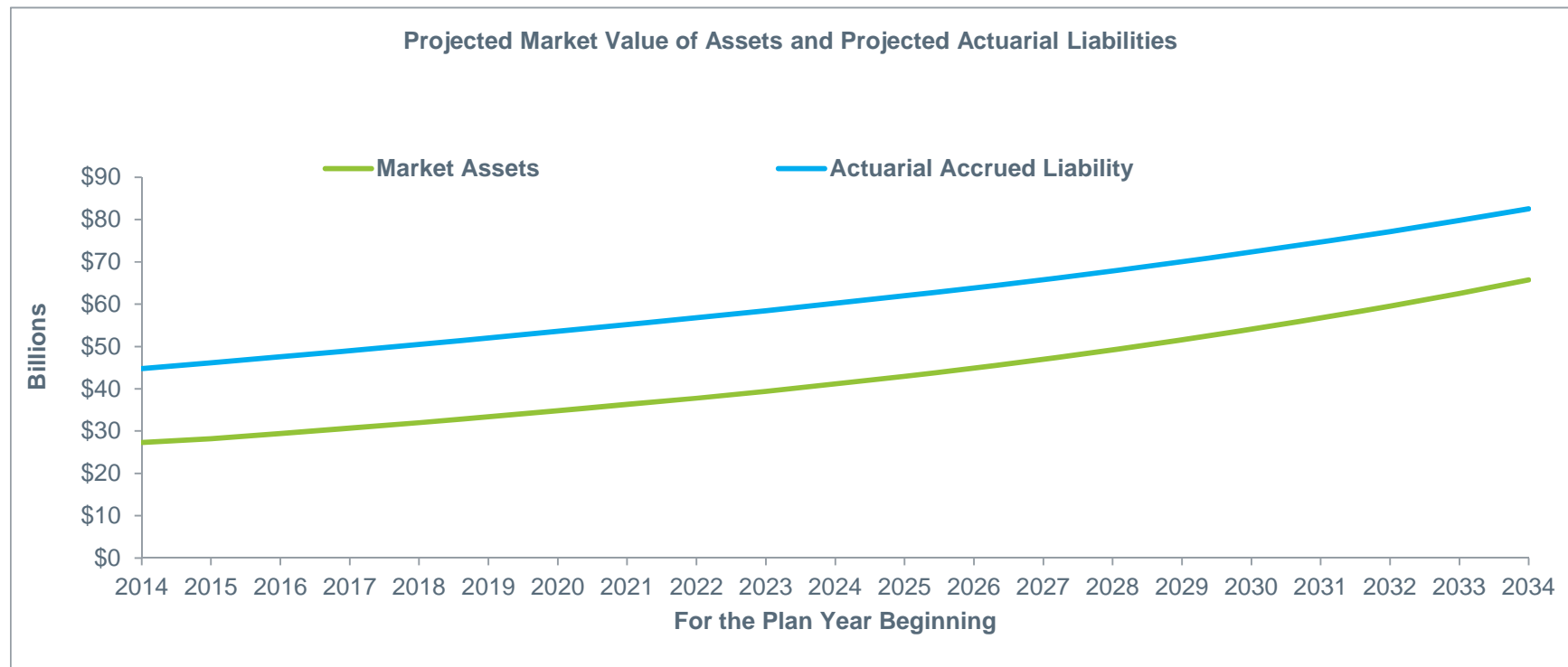
The Plan's projected benefit payments divided by projected contributions are shown in the chart below. The results assume the contribution policy remains unchanged, and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years.



Deterministic Analysis (continued)

Actuarial Accrued Liabilities and Market Value of Assets

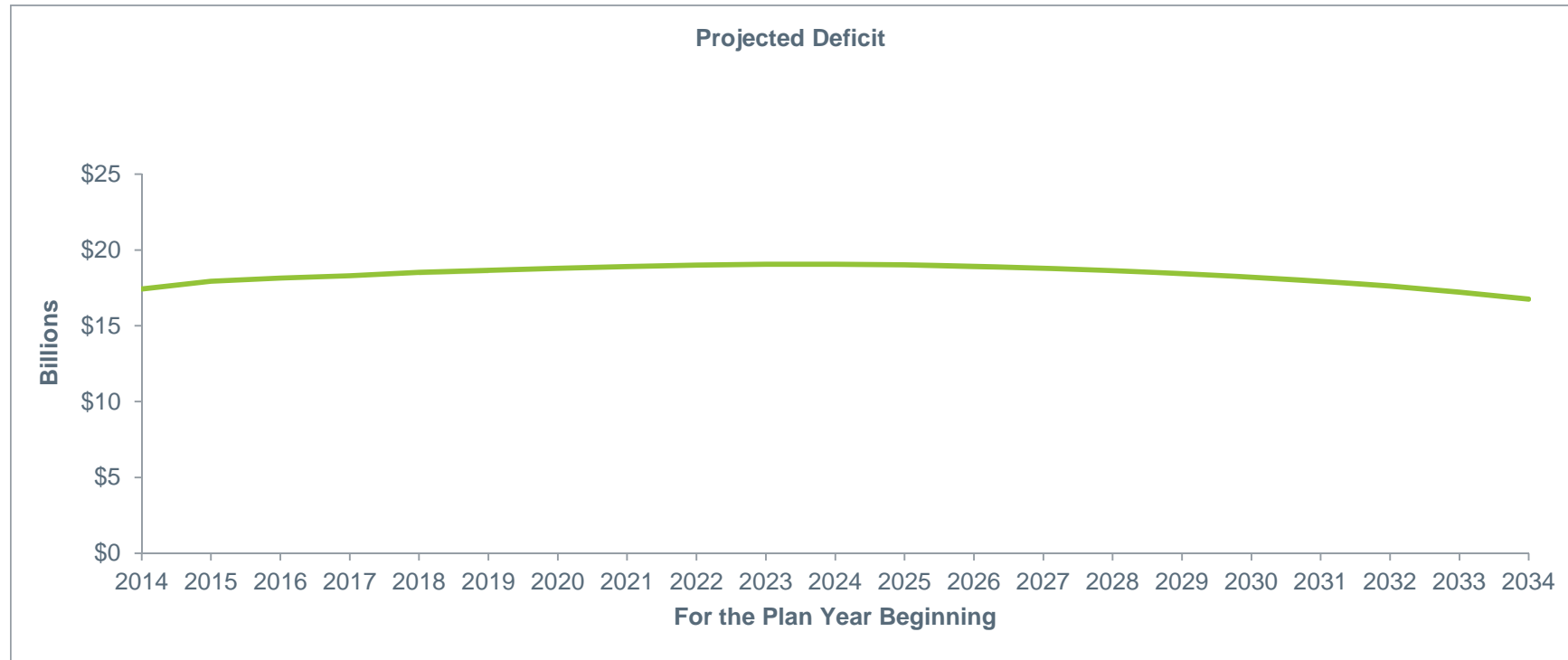
The Plan's projected actuarial accrued liabilities and market value of assets are shown in the chart below. The results assume the contribution policy remains unchanged, and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years. The relative disparity between the market value of assets and Plan liabilities is expected to decrease by 4% through the end of the projection period. The funded ratio (based on market value of assets) is expected to gradually increase to 80% by the end of the projection period. This is shown more clearly on the following pages.



Deterministic Analysis (continued)

Deficit (market value of assets – actuarial accrued liabilities)

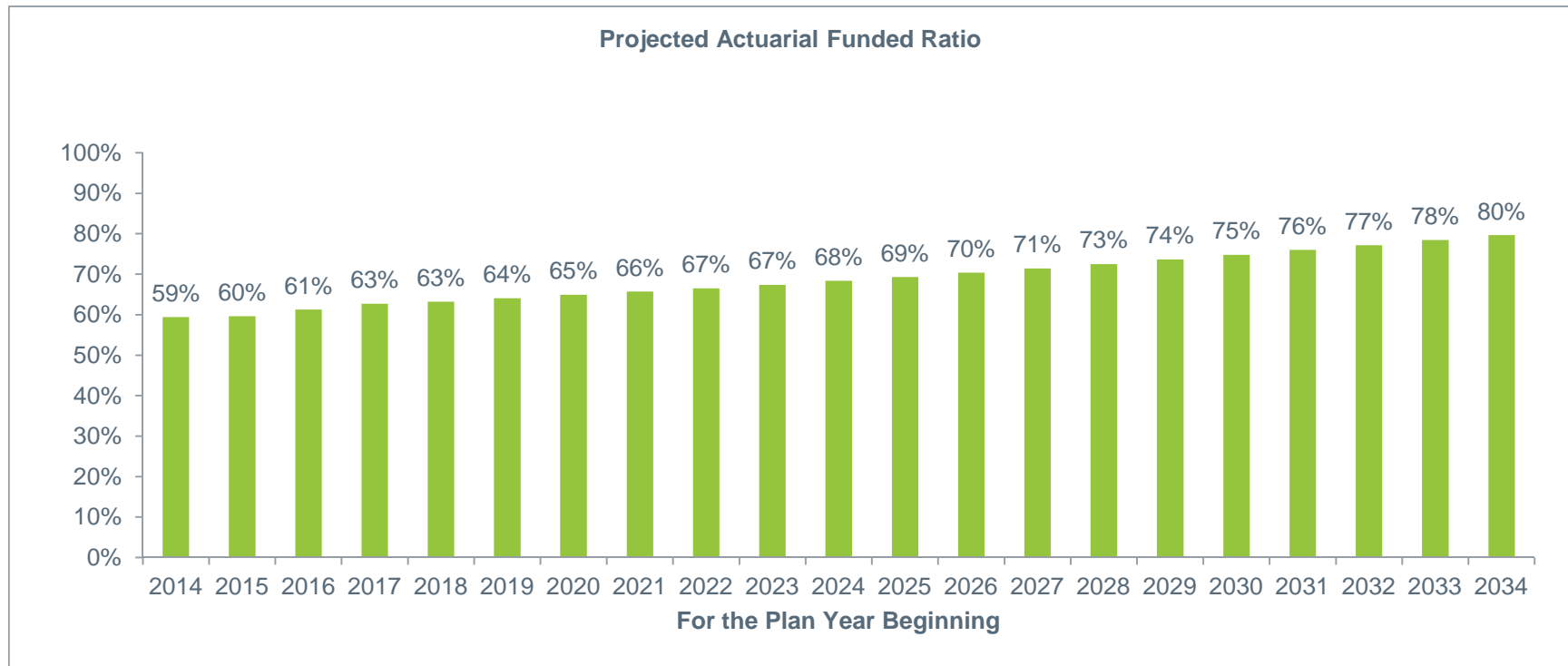
The Plan's projected deficit of assets is shown in the chart below. The results assume the contribution policy remains unchanged, and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years. The disparity between the market value of assets and Plan liabilities is expected to decrease by the end of the projection period by 4%.



Deterministic Analysis (continued)

Actuarial Funded Ratio (actuarial value of assets/actuarial accrued liability)

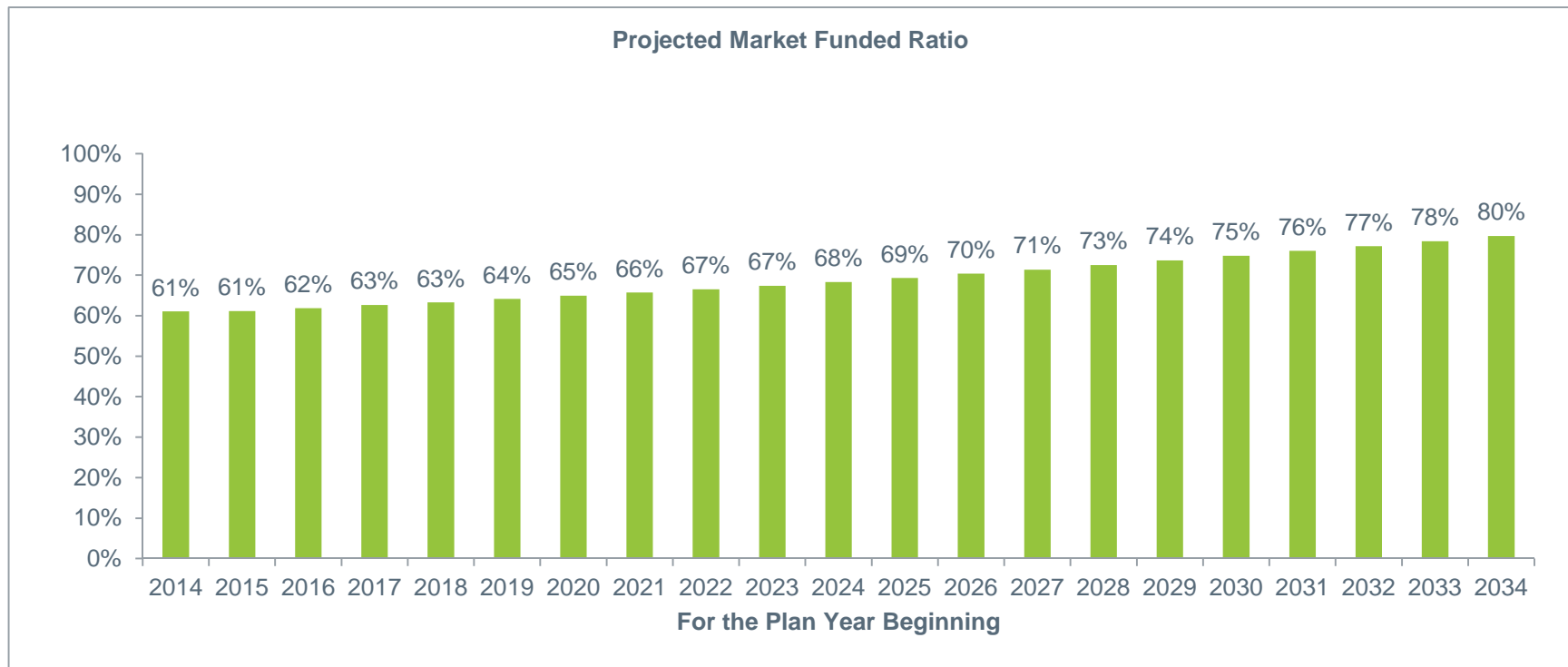
The Plan's projected actuarial funded ratio is shown in the chart below. The Plan is expected to end the projection period at approximately 80% funded. The results assume the contribution policy remains unchanged, and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years.



Deterministic Analysis (continued)

Market Funded Ratio (market value of assets/actuarial accrued liability)

The Plan's projected market funded ratio is shown in the chart below. The Plan is expected to end the projection period at approximately 80% funded. The results assume the contribution policy remains unchanged, and that the Plan's assets return precisely the actuarially assumed rate each year without exception for all projection years.

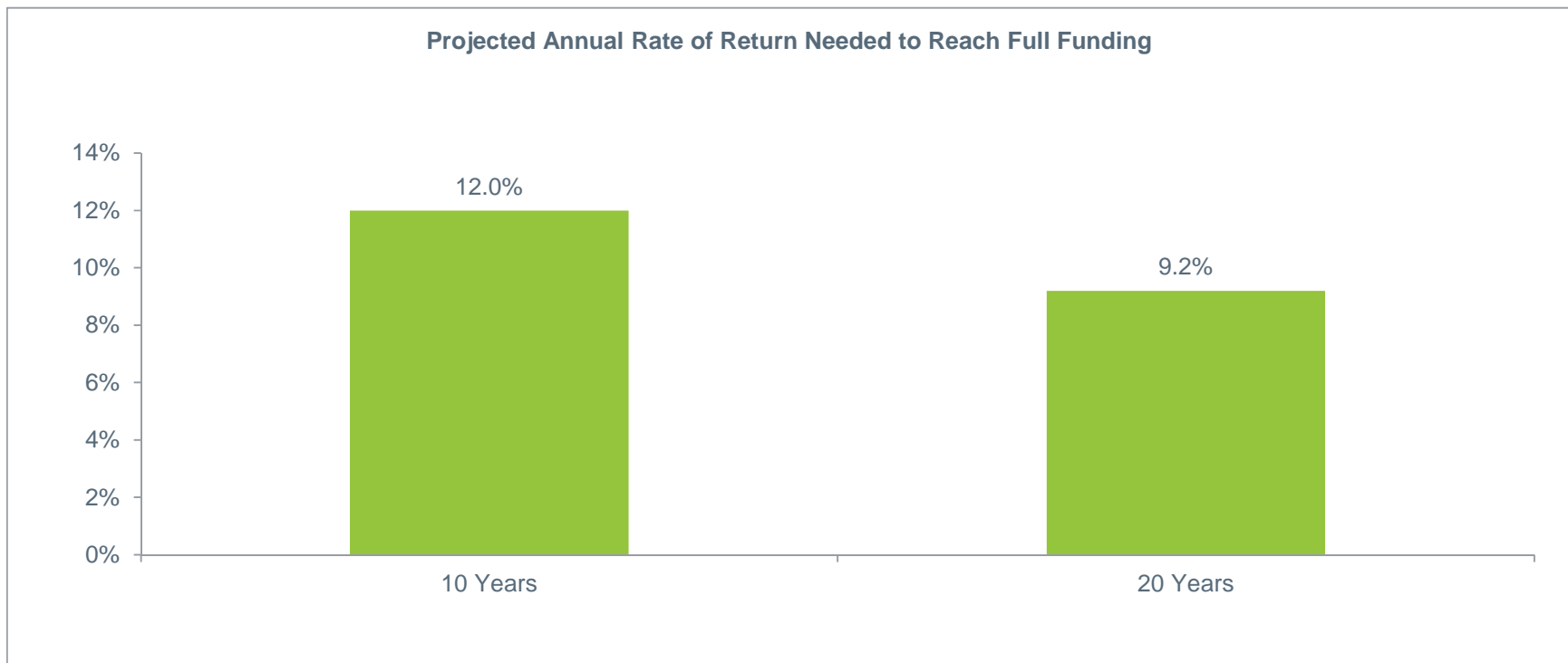


Deterministic Scenario Analysis

Full Funding Implied Returns

The figure below shows the projected investment return for the total fund needed to bring the Plan to 100% funding (on a market value basis) in 10 and 20 years, respectively. The results assume all other actuarial assumptions are precisely met over the time periods shown and that these returns are earned for every year, without variance.

Actuarially assumed rate of return – **7.5%**



Deterministic Scenario Analysis (continued)

Sensitivity Analysis – Decreased Return

Under the deterministic analysis presented in the preceding pages, the Plan is projected to have a market funded ratio of 80% in 20 years. The table below summarizes the projected funded ratio and other key statistics in 2034 assuming the Plan experiences an annualized investment return of 100 basis points lower (6.50%) than the current actuarially assumed rate of return (7.50%). The values assume all other actuarial assumptions are exactly met. The original values are also presented in the table for comparison.

	Value in 2034			
	Actuarially Assumed Rate of Return	Reduced Return (100 bps)	Impact of Reduced Return	
Projected Payout Ratio	7%	9%	1%	▲
Projected Employer Contributions (billions)	\$2.9	\$3.5	\$0.6	▲
Projected Benefit Payments/Projected Total Contributions	140%	119%	-21%	▼
Projected Actuarial Accrued Liabilities (billions)	\$82.5	\$82.5	\$0.0	↔
Projected Market Value of Assets (billions)	\$65.8	\$57.8	(\$8.0)	▼
Projected Deficit (billions)	\$16.8	\$24.7	\$7.9	▲
Projected Market Funded Ratio	80%	70%	-10%	▼
	20 Year Cumulative Total			
Projected Cumulative Employer Contributions (billions)	\$48.4	\$53.6	\$5.2	▲

Values in impact column may be impacted by rounding.

Deterministic Scenario Analysis (continued)

Sensitivity Analysis – Decreased Contributions

Under the deterministic analysis presented in the preceding pages, the Plan is projected to have a market funded ratio of 80% in 20 years. The table below summarizes the projected funded ratio and other key statistics in 2034 assuming employer contributions are held constant at the current level of 25% of salary. The values assume all other actuarial assumptions are exactly met. The original values are also presented in the table for comparison.

	Value in 2034			
	Current Contribution Policy	Constant Employer Contribution	Impact of Decreased Contributions	
Projected Payout Ratio	7%	9%	2%	▲
Projected Employer Contributions (billions)	\$2.9	\$2.7	(\$0.2)	▼
Projected Benefit Payments/Projected Total Contributions	140%	146%	6%	▲
Projected Actuarial Accrued Liabilities (billions)	\$82.5	\$82.5	\$0.0	↔
Projected Market Value of Assets (billions)	\$65.8	\$54.2	(\$11.6)	▼
Projected Deficit (billions)	\$16.8	\$28.4	\$11.6	▲
Projected Market Funded Ratio	80%	66%	-14%	▼
	20 Year Cumulative Total			
Projected Cumulative Employer Contributions (billions)	\$48.4	\$43.3	(\$5.1)	▼

Values in impact column may be impacted by rounding.

Stochastic Analysis

In the previous section of this report, we assumed the Plan operated going forward with certain knowledge of the future investment returns earned by the Plan's assets. This section introduces the element of uncertainty in those future investment returns. This part of the analysis examines Plan assets and liabilities under many capital market environments based on expected future asset returns and inflation, and their expected volatility. Using a Monte Carlo simulation technique, both assets and liabilities are assumed to vary stochastically, linked together by changes in inflation.

Using the current expected values and variances of the returns and inflation, along with their correlations, 2,000 trials are generated to produce a distribution of results. A stochastic analysis can answer questions about the best/worst case outcomes along with the probability of such outcomes. This is contrasted with the deterministic analysis that provides an expected value if all current Plan assumptions are exactly met.

Stochastic Analysis (continued)

Long-Term Return and Risk Assumptions

In order to perform a stochastic analysis and create asset allocation alternatives, it is necessary to estimate, for each asset class, its probable return and risk. The expected returns are our best estimates of the average annual percentage increases in values of each asset class over a prospective long period of time, and assumed to be normally distributed. The risk of an asset class is measured by its standard deviation, or volatility. If asset returns are normally distributed, two-thirds (67%) of all returns are expected to lie within one standard deviation on either side of the mean. For example, we expect Global Equity to return, annually on average, 7.80% with a standard deviation of 18.35%, meaning that two-thirds of the time we expect its return to lie between -10.55% (= 7.80 – 18.35) and 26.15% (= 7.80 + 18.35). Moreover, we expect 95% of all return outcomes to lie within two standard deviations of the mean return, implying only a one-in-twenty chance that the return on Global Equity will either fall below -28.90% or rise above 44.50%. The risk and return assumptions used in this study are outlined in the below table and chart:

Asset Class	Arithmetic Return Assumption	Standard Deviation Assumption
Global Equity	7.80	18.35
SERS Custom Fixed Income	4.13	6.66
Long-Biased L/S Equity	7.25	13.00
Private Equity	10.50	26.00
SERS Custom Real Estate	7.41	13.64
Cash Equivalents	2.25	3.00



Stochastic Analysis (continued)

Correlation Between Asset Classes

Creating a diversified portfolio of asset classes enables the investor to achieve a high rate of return while minimizing volatility of the portfolio. As defined on the previous page, volatility is “risk” or standard deviation. By minimizing the volatility of a portfolio, we produce asset returns that vary less from year to year. Diversification exists because the returns of different asset classes do not always move in the same direction, at the same time, or with the same magnitude. Correlation values are between 1.00 and –1.00. If returns of two asset classes rise or fall at the same time and in the same magnitude, they have a correlation value of 1.00. Conversely, two asset classes that simultaneously move in opposite directions, and in the same magnitude, have a correlation value of –1.00. A correlation of zero indicates no relationship between returns. The assumed correlations are largely based on historical index data, with some qualitative analysis applied. For instance, where appropriate, we have weighted current history more heavily. The correlation matrix used in this study is shown below:

	Global Equity	SERS Custom Fixed Income	Long-Biased L/S Equity	Private Equity	SERS Custom Real Estate	Cash Equivalents
Global Equity	1.00	0.37	0.82	0.78	0.56	-0.05
SERS Custom Fixed Income	0.37	1.00	0.28	0.14	0.25	-0.01
Long-Biased L/S Equity	0.82	0.28	1.00	0.72	0.47	0.05
Private Equity	0.78	0.14	0.72	1.00	0.71	0.07
SERS Custom Real Estate	0.56	0.25	0.47	0.71	1.00	0.09
Cash Equivalents	-0.05	-0.01	0.05	0.07	0.09	1.00

The fact that the correlations shown in the table are nearly all positive does not imply that these asset classes do not diversify one another. Their correlations are significantly less than 1.00, meaning we expect a measurable number of instances when the underperformance of one or more of the asset classes will be offset by the outperformance of others. This point is demonstrated on the following pages, which illustrate that diversification into less correlated asset classes can decrease the expected overall volatility of a portfolio.

Stochastic Analysis (continued)

Efficient Portfolios

Each frontier portfolio (optimal allocation) is created using target rates of return both above and below the projected rate of return for the current allocation. This range illustrates the trade-off between return and risk; additional return can only be achieved by undertaking additional risk. The table below shows the possible optimal allocations given the selected asset classes and their constraints listed under "Min" and "Max." The table shows the Current Allocation and highlights four potential targets (Portfolios 1, 2, 3, and 4) for consideration throughout this study. Two illustrative portfolios (Conservative and Aggressive Portfolios) are also shown for demonstrative purposes.

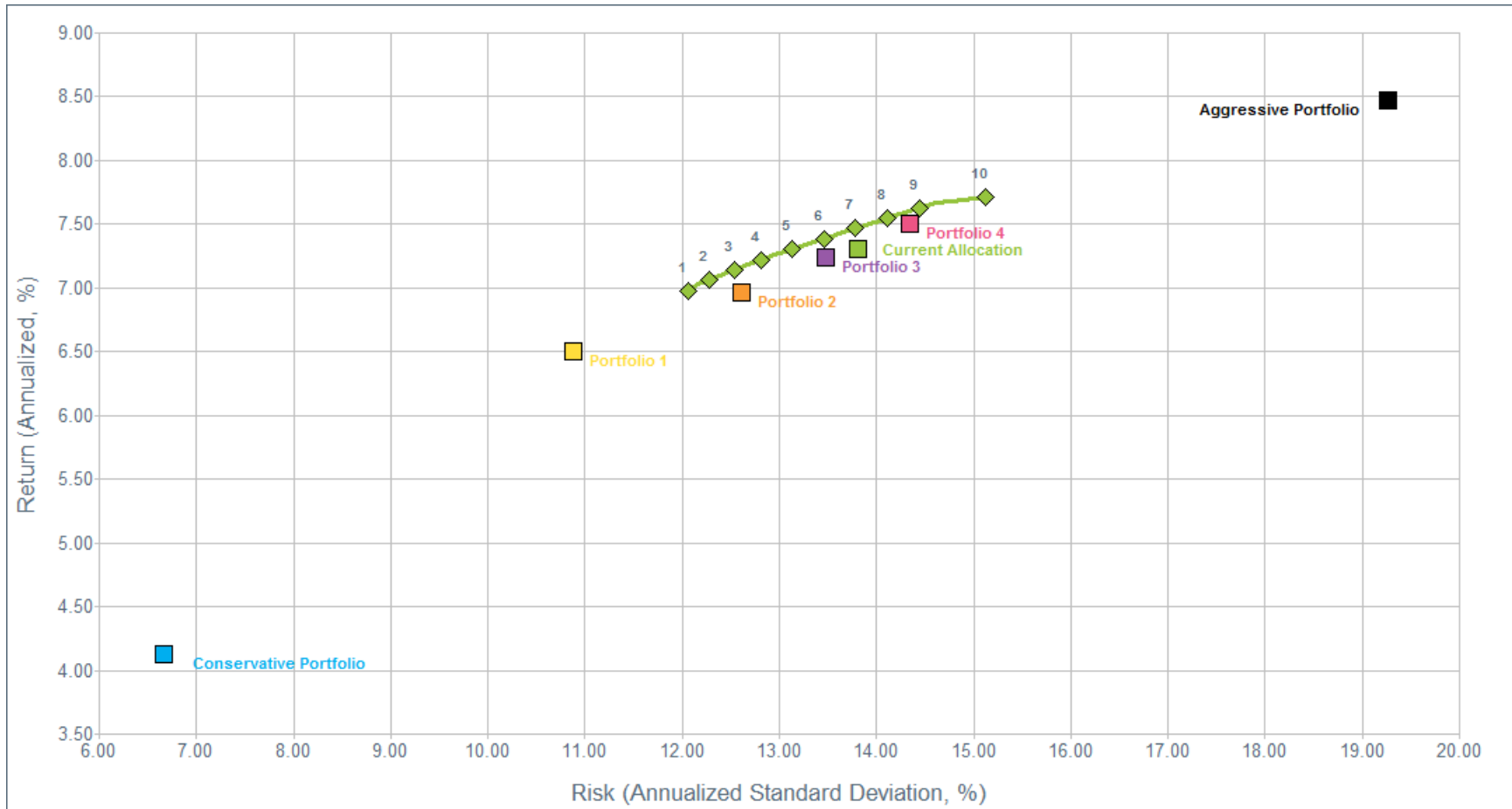
	Min	Max	1	2	3	4	5	6	7	8	9	10	Curr	Cons	1	2	3	4	Aggr
Global Equity	25	45	27	25	25	25	27	29	32	34	36	45	39	0	30	38	40	42	75
SERS Custom Fixed Income	10	25	25	25	23	22	20	18	15	13	11	10	18	100	40	26	20	14	0
Long-Biased L/S Equity	5	15	15	15	15	15	15	15	15	15	15	7	8	0	10	8	9	10	0
Private Equity	15	20	15	17	19	20	20	20	20	20	20	20	19	0	10	14	16	18	25
SERS Custom Real Estate	10	15	15	15	15	15	15	15	15	15	15	15	11	0	10	11	12	13	0
Cash Equivalents	3	3	3	3	3	3	3	3	3	3	3	3	5	0	0	3	3	3	0
Total			100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Capital Appreciation			52	52	53	54	56	57	59	61	62	71	65	25	52	61	64	66	100
Capital Preservation			20	19	19	18	16	15	13	12	10	10	17	67	27	20	16	12	0
Alpha			15	15	15	15	15	15	15	15	15	7	8	0	10	8	9	10	0
Inflation			14	14	13	13	13	13	13	13	12	12	10	8	11	11	11	11	0
Expected Return			6.98	7.06	7.14	7.22	7.30	7.39	7.47	7.55	7.63	7.71	7.31	4.13	6.51	6.97	7.24	7.50	8.47
Risk (Standard Deviation)			12.06	12.27	12.54	12.81	13.13	13.46	13.79	14.12	14.45	15.12	13.81	6.66	10.88	12.61	13.47	14.35	19.27
Return (Compound)			6.31	6.36	6.41	6.46	6.51	6.56	6.60	6.63	6.67	6.66	6.43	3.92	5.96	6.23	6.40	6.55	6.80
Return/Risk Ratio			0.58	0.58	0.57	0.56	0.56	0.55	0.54	0.53	0.53	0.51	0.53	0.62	0.60	0.55	0.54	0.52	0.44
RVK Expected Eq Beta			0.59	0.60	0.61	0.62	0.64	0.66	0.68	0.70	0.72	0.76	0.69	0.12	0.54	0.63	0.68	0.72	0.99
RVK Liquidity Metric			57	55	54	53	53	53	54	54	54	59	61	77	65	64	62	60	69

Stochastic Analysis (continued)

Efficient Frontier

The risk of each alternative allocation is plotted against the horizontal axis, while the return is measured on the vertical axis. The line connecting the points represents all the optimal portfolios subject to the given constraints and is known as the "efficient frontier." The upward slope of the efficient frontier indicates the direct relationship between return and risk.

Efficient Frontier



Stochastic Analysis (continued)

Asset Mixes

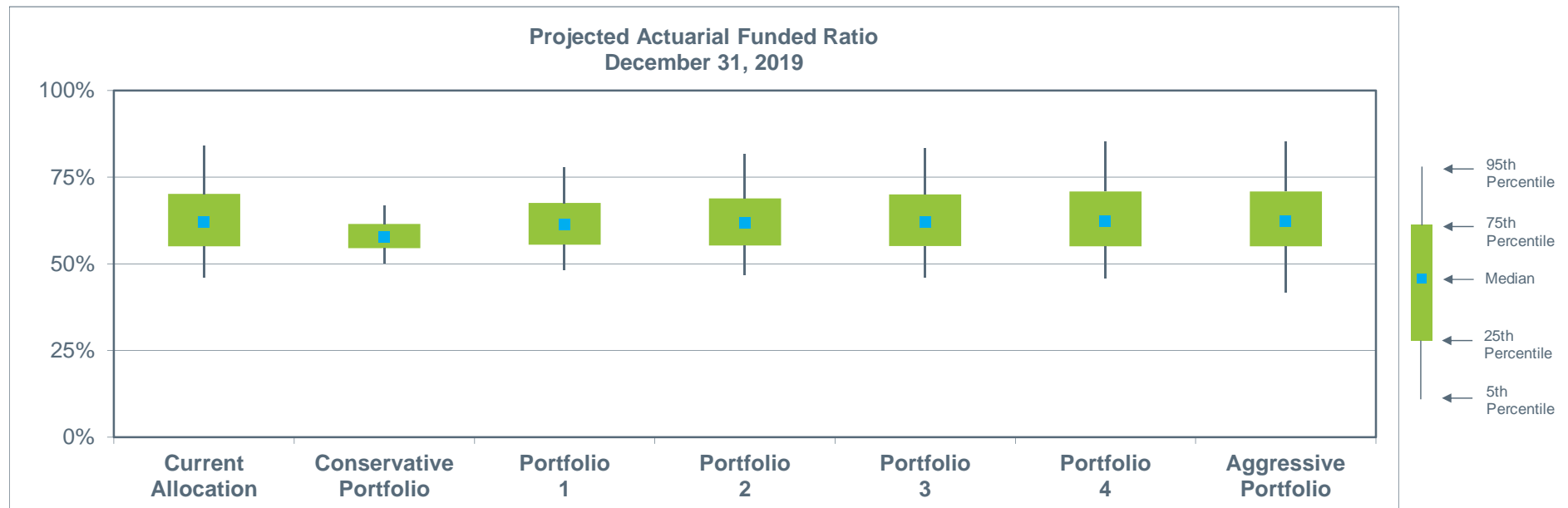
Outlined below are the Current Allocation and six other mixes to be examined in this stochastic analysis. The expected return, expected risk (as measured by standard deviation), and RVK Liquidity Metric, for each is also shown.

Asset Class	Current Allocation	Conservative Portfolio	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Aggressive Portfolio
Global Equity	39%	0%	30%	38%	40%	42%	75%
SERS Custom Fixed Income	18%	100%	40%	26%	20%	14%	0%
Long-Biased L/S Equity	8%	0%	10%	8%	9%	10%	0%
Private Equity	19%	0%	10%	14%	16%	18%	25%
SERS Custom Real Estate	11%	0%	10%	11%	12%	13%	0%
Cash Equivalents	5%	0%	0%	3%	3%	3%	0%
Total Equity	66%	0%	50%	60%	65%	70%	100%
Expected Return	7.31%	4.13%	6.51%	6.97%	7.24%	7.50%	8.47%
Expected Risk	13.81%	6.66%	10.88%	12.61%	13.47%	14.35%	19.27%
RVK Liquidity Metric	61	77	65	64	62	60	69

Stochastic Analysis (continued)

Projected Actuarial Funded Ratio (actuarial value of assets/actuarial accrued liability); 5 Years

The graph below shows the distribution of possible actuarial funded ratios five years from now, assuming the seven different asset mixes highlighted on the prior pages. The results assume the current contribution policy remains unchanged for all projection years.

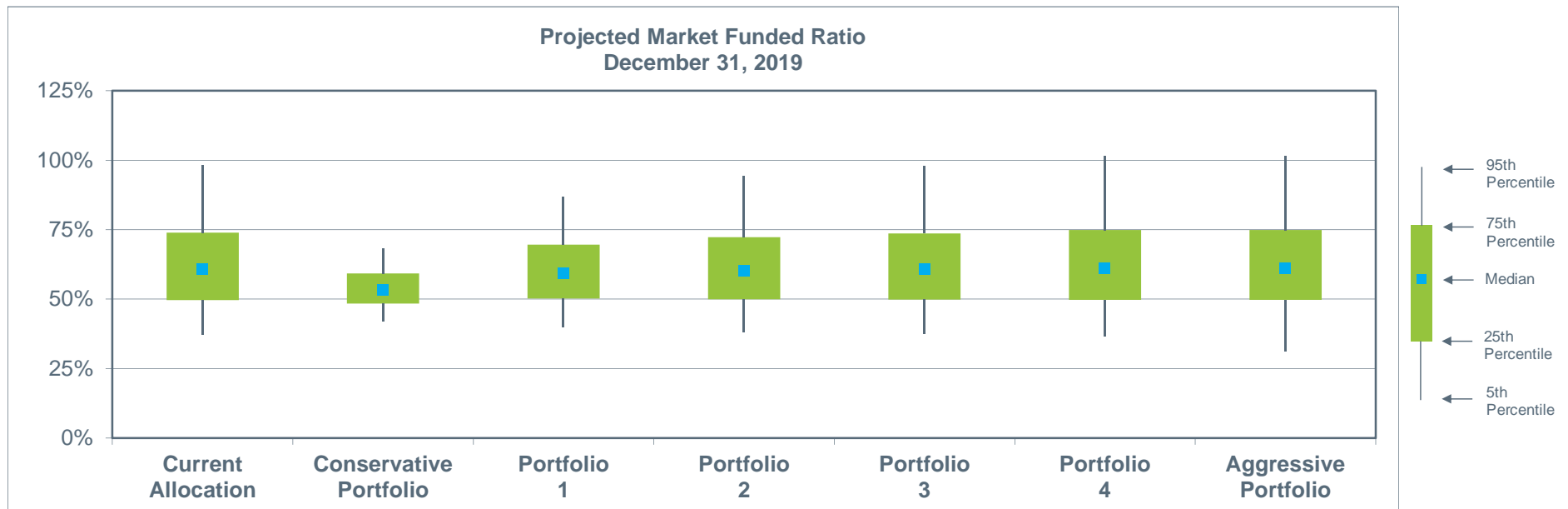


	Current Allocation		Conservative Portfolio		Portfolio 1		Portfolio 2		Portfolio 3		Portfolio 4		Aggressive Portfolio	
	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio
5th Percentile	\$27.7	46%	\$26.0	50%	\$26.8	48%	\$27.5	47%	\$27.7	46%	\$28.0	46%	\$30.3	42%
25th Percentile	\$23.3	55%	\$23.5	55%	\$23.0	55%	\$23.1	55%	\$23.2	55%	\$23.3	55%	\$24.2	53%
Median	\$19.5	62%	\$21.7	58%	\$19.9	61%	\$19.7	62%	\$19.5	62%	\$19.4	62%	\$19.1	63%
75th Percentile	\$15.5	70%	\$19.9	61%	\$16.9	68%	\$16.1	69%	\$15.7	70%	\$15.2	71%	\$13.2	75%
95th Percentile	\$8.5	84%	\$17.3	67%	\$11.5	78%	\$9.7	82%	\$8.8	83%	\$7.8	85%	\$2.7	95%

Stochastic Analysis (continued)

Projected Market Funded Ratio (market value of assets/actuarial accrued liability); 5 Years

The graph below shows the distribution of possible market funded ratios five years from now, assuming the seven different asset mixes highlighted on the prior pages. The results assume the current contribution policy remains unchanged for all projection years.

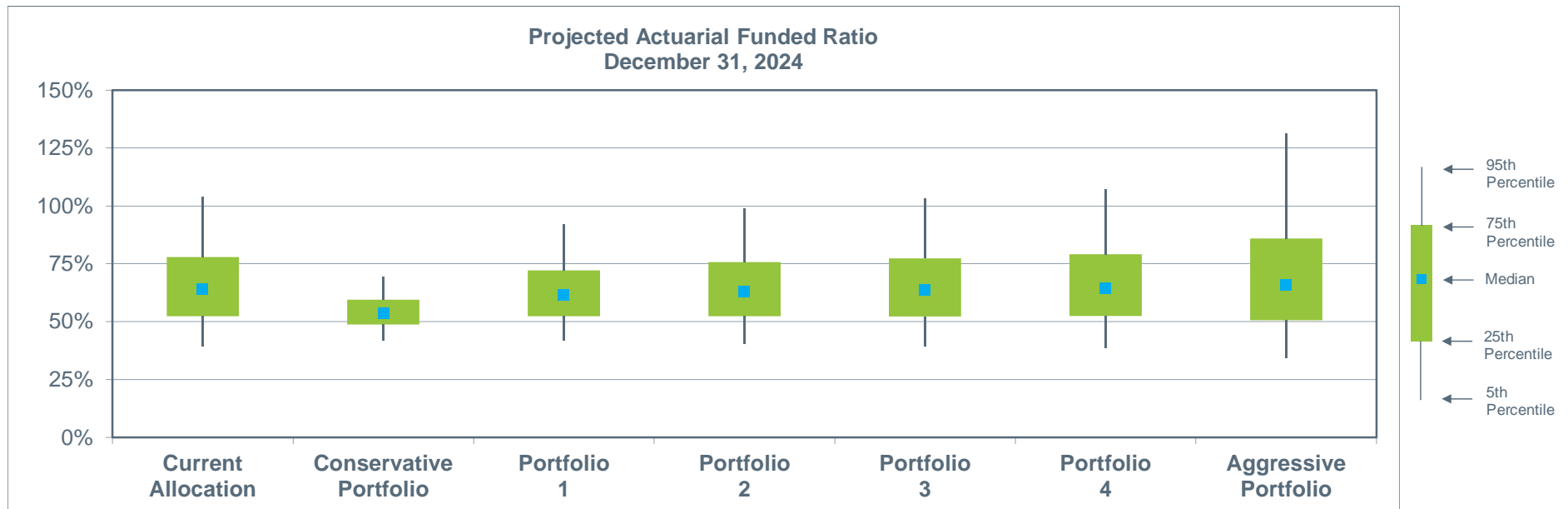


	Current Allocation		Conservative Portfolio		Portfolio 1		Portfolio 2		Portfolio 3		Portfolio 4		Aggressive Portfolio	
	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio
5th Percentile	\$31.8	37%	\$29.6	42%	\$30.5	40%	\$31.3	38%	\$31.7	37%	\$32.1	37%	\$34.8	31%
25th Percentile	\$25.7	50%	\$26.4	48%	\$25.4	50%	\$25.7	50%	\$25.6	50%	\$25.8	50%	\$27.0	47%
50th Percentile	\$20.2	61%	\$24.1	53%	\$21.0	59%	\$20.5	60%	\$20.2	61%	\$20.0	61%	\$19.6	62%
75th Percentile	\$13.6	74%	\$21.3	59%	\$15.8	70%	\$14.5	72%	\$13.7	74%	\$13.0	75%	\$9.8	81%
95th Percentile	\$0.9	98%	\$16.8	68%	\$6.8	87%	\$3.0	94%	\$1.2	98%	(\$0.8)	102%	(\$10.5)	120%

Stochastic Analysis (continued)

Projected Actuarial Funded Ratio (actuarial value of assets/actuarial accrued liability); 10 Years

The graph below shows the distribution of possible actuarial funded ratios ten years from now, assuming the seven different asset mixes highlighted on the prior pages. The results assume the current contribution policy remains unchanged for all projection years.

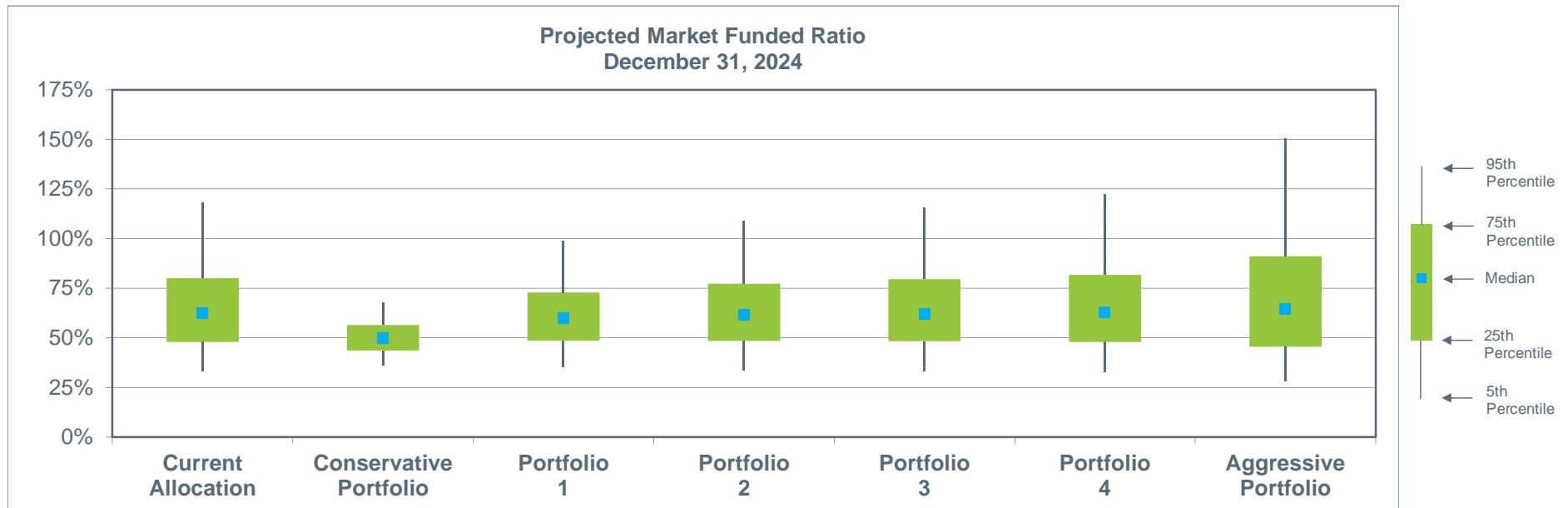


	Current Allocation		Conservative Portfolio		Portfolio 1		Portfolio 2		Portfolio 3		Portfolio 4		Aggressive Portfolio	
	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio
5th Percentile	\$35.3	39%	\$34.5	42%	\$34.0	42%	\$34.8	40%	\$35.2	40%	\$35.6	39%	\$38.3	34%
25th Percentile	\$28.4	52%	\$30.5	49%	\$28.1	52%	\$28.2	52%	\$28.2	52%	\$28.3	52%	\$29.4	51%
Median	\$21.6	64%	\$27.6	54%	\$22.8	61%	\$22.1	63%	\$21.7	64%	\$21.3	64%	\$20.5	66%
75th Percentile	\$13.4	78%	\$24.5	60%	\$16.9	72%	\$14.9	76%	\$13.7	77%	\$12.6	79%	\$8.3	86%
95th Percentile	(\$2.5)	104%	\$19.0	69%	\$5.0	92%	\$0.6	99%	(\$2.1)	103%	(\$4.8)	107%	(\$19.0)	131%

Stochastic Analysis (continued)

Projected Market Funded Ratio (market value of assets/actuarial accrued liability); 10 Years

The graph below shows the distribution of possible market funded ratios ten years from now, assuming the seven different asset mixes highlighted on the prior pages. The results assume the current contribution policy remains unchanged for all projection years.

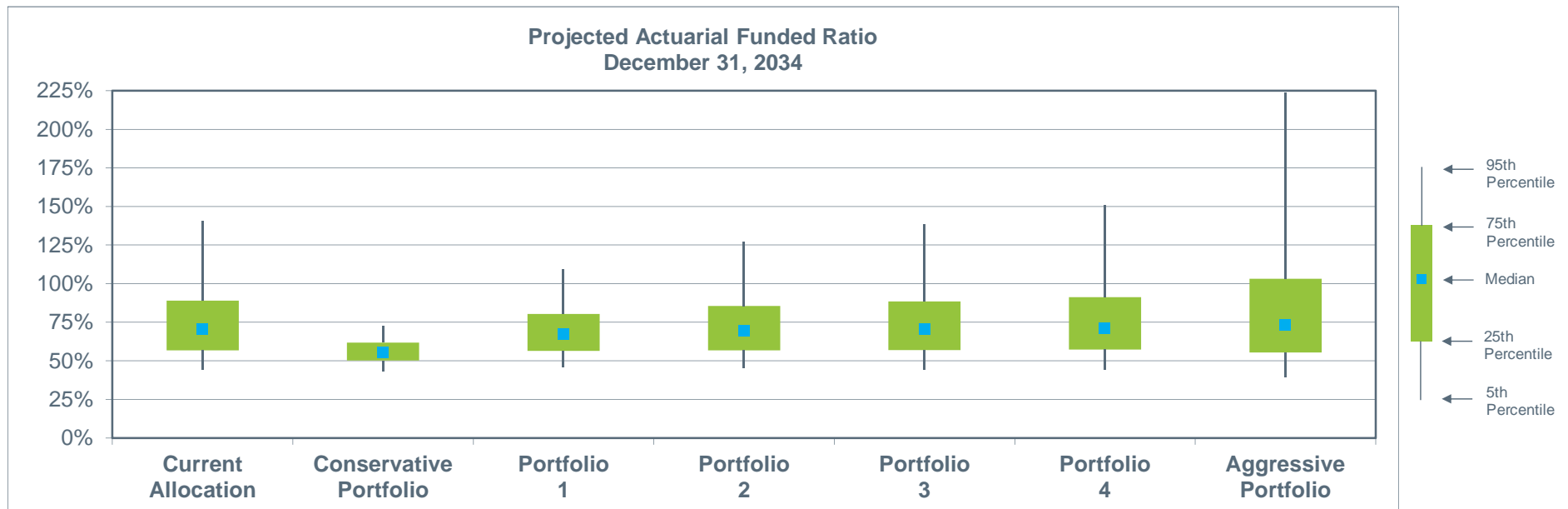


	Current Allocation		Conservative Portfolio		Portfolio 1		Portfolio 2		Portfolio 3		Portfolio 4		Aggressive Portfolio	
	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio
5th Percentile	\$38.7	33%	\$37.3	36%	\$37.0	35%	\$38.0	34%	\$38.5	33%	\$39.0	33%	\$41.9	28%
25th Percentile	\$30.3	48%	\$33.1	44%	\$30.2	49%	\$30.3	48%	\$30.2	48%	\$30.2	48%	\$31.8	46%
50th Percentile	\$22.4	62%	\$29.9	50%	\$24.1	60%	\$23.2	62%	\$22.6	62%	\$22.0	63%	\$21.3	64%
75th Percentile	\$12.1	80%	\$26.3	57%	\$16.4	73%	\$13.8	77%	\$12.4	80%	\$11.0	82%	\$5.3	91%
95th Percentile	(\$11.2)	118%	\$20.2	68%	\$0.7	99%	(\$5.8)	109%	(\$10.2)	116%	(\$14.1)	122%	(\$31.0)	151%

Stochastic Analysis (continued)

Projected Actuarial Funded Ratio (actuarial value of assets/actuarial accrued liability); 20 Years

The graph below shows the distribution of possible actuarial funded ratios twenty years from now, assuming the seven different asset mixes highlighted on the prior pages. The results assume the current contribution policy remains unchanged for all projection years.

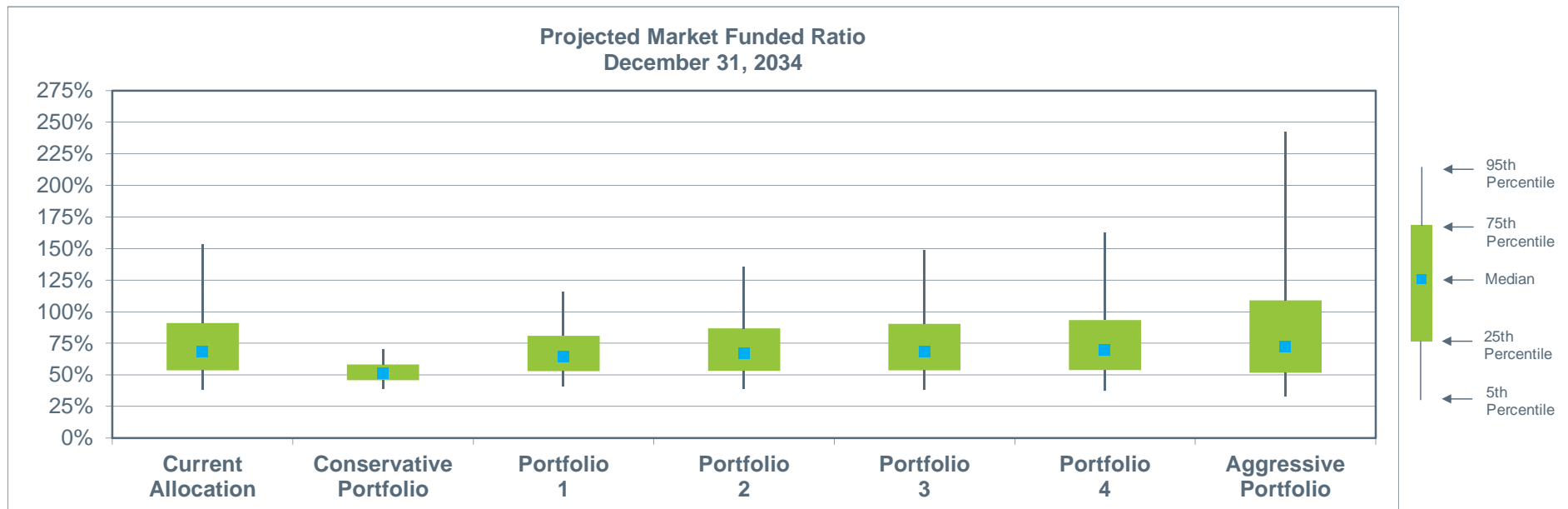


	Current Allocation		Conservative Portfolio		Portfolio 1		Portfolio 2		Portfolio 3		Portfolio 4		Aggressive Portfolio	
	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio
5th Percentile	\$45.6	44%	\$48.3	43%	\$44.6	46%	\$45.2	45%	\$45.4	44%	\$45.9	44%	\$49.4	39%
25th Percentile	\$34.2	57%	\$40.7	50%	\$34.3	56%	\$34.2	57%	\$34.0	57%	\$33.9	57%	\$35.4	55%
Median	\$24.0	70%	\$35.7	55%	\$26.6	67%	\$25.1	69%	\$24.1	70%	\$23.2	71%	\$21.5	73%
75th Percentile	\$9.3	89%	\$31.2	62%	\$16.0	80%	\$12.1	86%	\$9.8	89%	\$7.2	91%	(\$2.6)	103%
95th Percentile	(\$36.4)	141%	\$23.3	73%	(\$7.4)	109%	(\$24.1)	127%	(\$34.0)	138%	(\$44.1)	151%	(\$108.4)	224%

Stochastic Analysis (continued)

Projected Market Funded Ratio (market value of assets/actuarial accrued liability); 20 Years

The graph below shows the distribution of possible market funded ratios twenty years from now, assuming the seven different asset mixes highlighted on the prior pages. The results assume the current contribution policy remains unchanged for all projection years.



	Current Allocation		Conservative Portfolio		Portfolio 1		Portfolio 2		Portfolio 3		Portfolio 4		Aggressive Portfolio	
	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio	Unfunded Liability (Bil)	Funded Ratio
5th Percentile	\$50.5	38%	\$52.0	39%	\$48.4	41%	\$50.0	39%	\$50.4	38%	\$50.8	38%	\$55.6	33%
25th Percentile	\$36.9	53%	\$43.9	46%	\$37.1	53%	\$36.9	53%	\$36.7	54%	\$36.7	54%	\$38.3	52%
50th Percentile	\$25.4	69%	\$38.7	52%	\$28.4	65%	\$26.5	67%	\$25.6	68%	\$24.4	70%	\$21.9	72%
75th Percentile	\$7.6	91%	\$34.1	58%	\$16.1	81%	\$10.9	87%	\$7.9	90%	\$5.3	94%	(\$7.3)	109%
95th Percentile	(\$46.1)	153%	\$25.7	70%	(\$14.4)	116%	(\$31.8)	136%	(\$41.9)	149%	(\$54.8)	162%	(\$121.1)	242%

Stochastic Analysis (continued)

Projected Market Funded Ratio and Maximum 1 Year Investment Loss (market value of assets/actuarial accrued liability)

The tables below show the probability that the Plan will be at various funding levels for each of the seven different asset mixes highlighted on the prior pages. The tables also illustrate the maximum 1 year investment loss each portfolio is expected to experience during the given time period. The results assume the current contribution policy remains unchanged for all projection years.

5 Years	Probability of Full Funding in 2019	Probability of < 61% (Current) Funding in 2019	Probability of < 50% Funding in 2019	Maximum 1 Year Investment Loss
Current Allocation	5%	51%	26%	-33%
Conservative Portfolio	0%	81%	32%	-17%
Portfolio 1	1%	54%	24%	-27%
Portfolio 2	3%	51%	25%	-30%
Portfolio 3	4%	51%	25%	-32%
Portfolio 4	5%	50%	26%	-34%
Aggressive Portfolio	11%	48%	30%	-43%

10 Years	Probability of Full Funding in 2024	Probability of < 61% (Current) Funding in 2024	Probability of < 50% Funding in 2024	Maximum 1 Year Investment Loss
Current Allocation	10%	47%	28%	-33%
Conservative Portfolio	0%	86%	50%	-22%
Portfolio 1	5%	52%	28%	-27%
Portfolio 2	8%	49%	28%	-30%
Portfolio 3	10%	47%	28%	-32%
Portfolio 4	11%	46%	27%	-34%
Aggressive Portfolio	19%	46%	31%	-46%

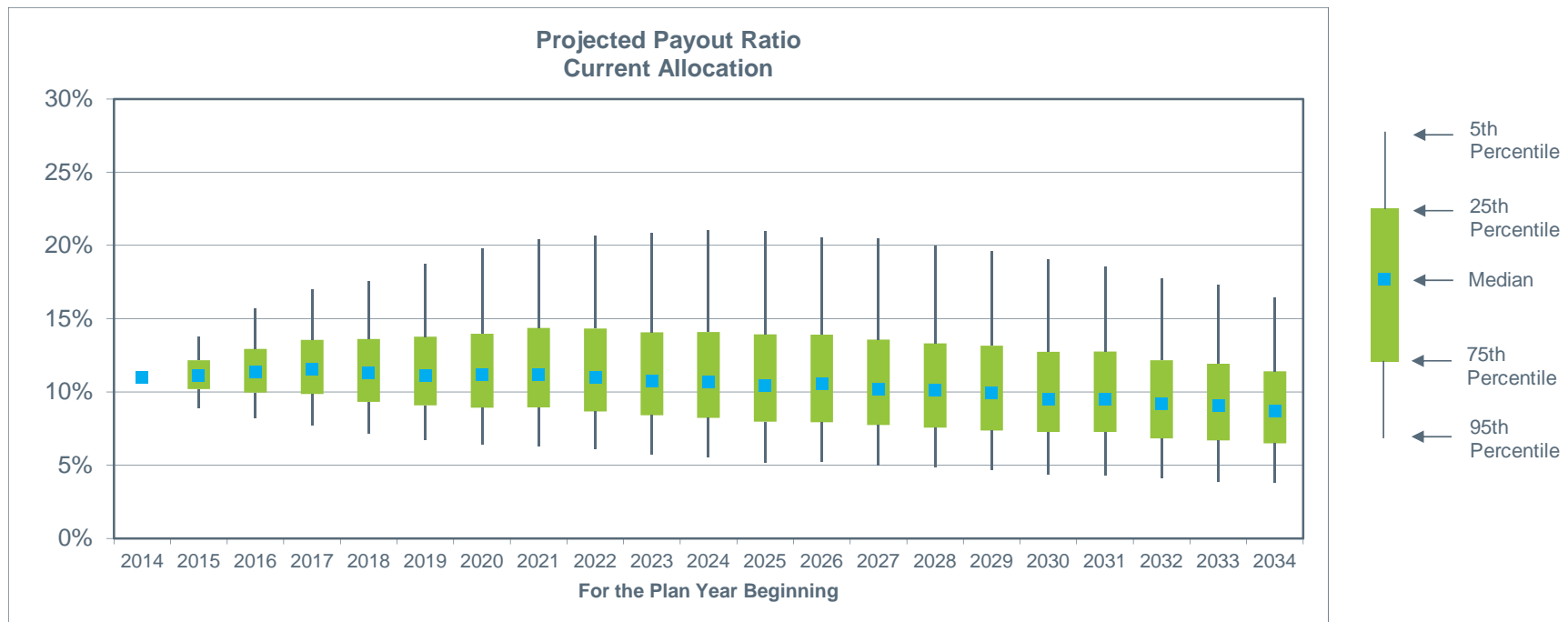
20 Years	Probability of Full Funding in 2034	Probability of < 61% (Current) Funding in 2034	Probability of < 50% Funding in 2034	Maximum 1 Year Investment Loss
Current Allocation	19%	39%	20%	-36%
Conservative Portfolio	0%	82%	42%	-25%
Portfolio 1	10%	43%	19%	-29%
Portfolio 2	16%	40%	20%	-33%
Portfolio 3	18%	39%	20%	-35%
Portfolio 4	21%	37%	20%	-37%
Aggressive Portfolio	29%	37%	23%	-48%

Stochastic Analysis (continued)

Projected Payout Ratio (expected benefit payments/market value of assets); **Current Allocation**

The graph below displays the range of possible payout ratios over the next twenty years, assuming the Plan's assets are allocated according to the **Current Allocation**. The results assume the current contribution policy remains unchanged for all projection years.

The median annual benefit payment as percentage of the market value of assets is expected to range between 9% and 12%. The worst-case scenario could reach 21% or higher.



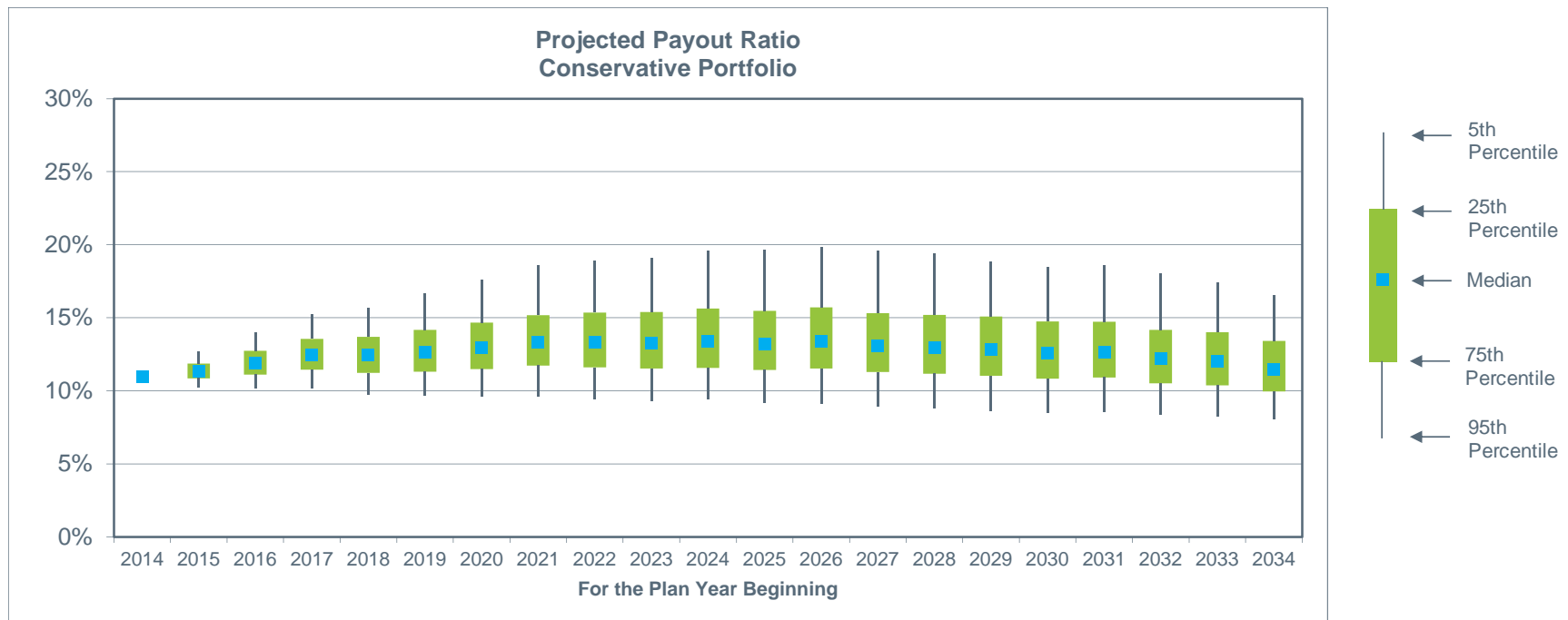
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Median	11%	11%	11%	12%	11%	11%	11%	11%	11%	11%	11%	10%	11%	10%	10%	10%	10%	10%	9%	9%	9%

Stochastic Analysis (continued)

Projected Payout Ratio (expected benefit payments/market value of assets); **Conservative Portfolio**

The graph below displays the range of possible payout ratios over the next twenty years, assuming the Plan's assets are allocated according to the **Conservative Portfolio**. The results assume the current contribution policy remains unchanged for all projection years.

The median annual benefit payment as percentage of the market value of assets is expected to range between 11% and 13%. The worst-case scenario could reach 20% or higher.



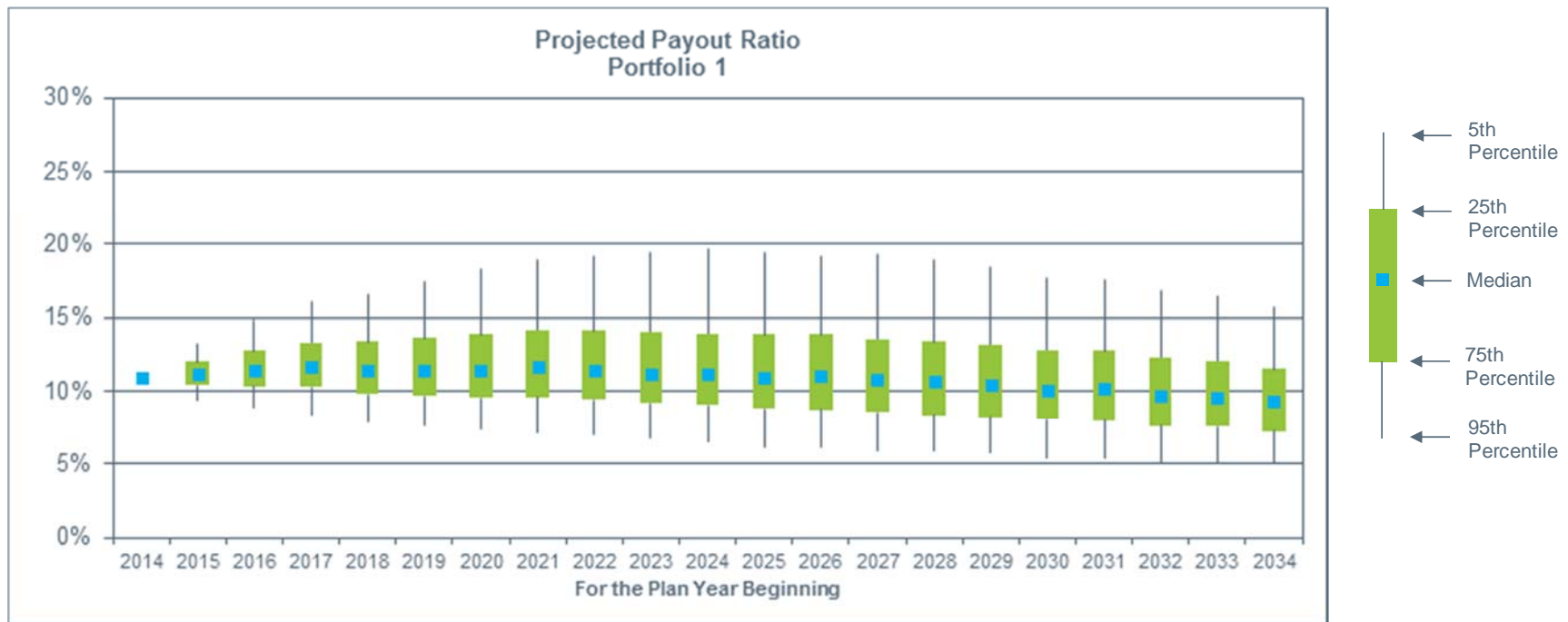
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
Median	11%	11%	12%	12%	12%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	12%	12%	11%

Stochastic Analysis (continued)

Projected Payout Ratio (expected benefit payments/market value of assets); **Portfolio 1**

The graph below displays the range of possible payout ratios over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 1**. The results assume the current contribution policy remains unchanged for all projection years.

The median annual benefit payment as percentage of the market value of assets is expected to range between 9% and 12%. The worst-case scenario could reach 20% or higher.



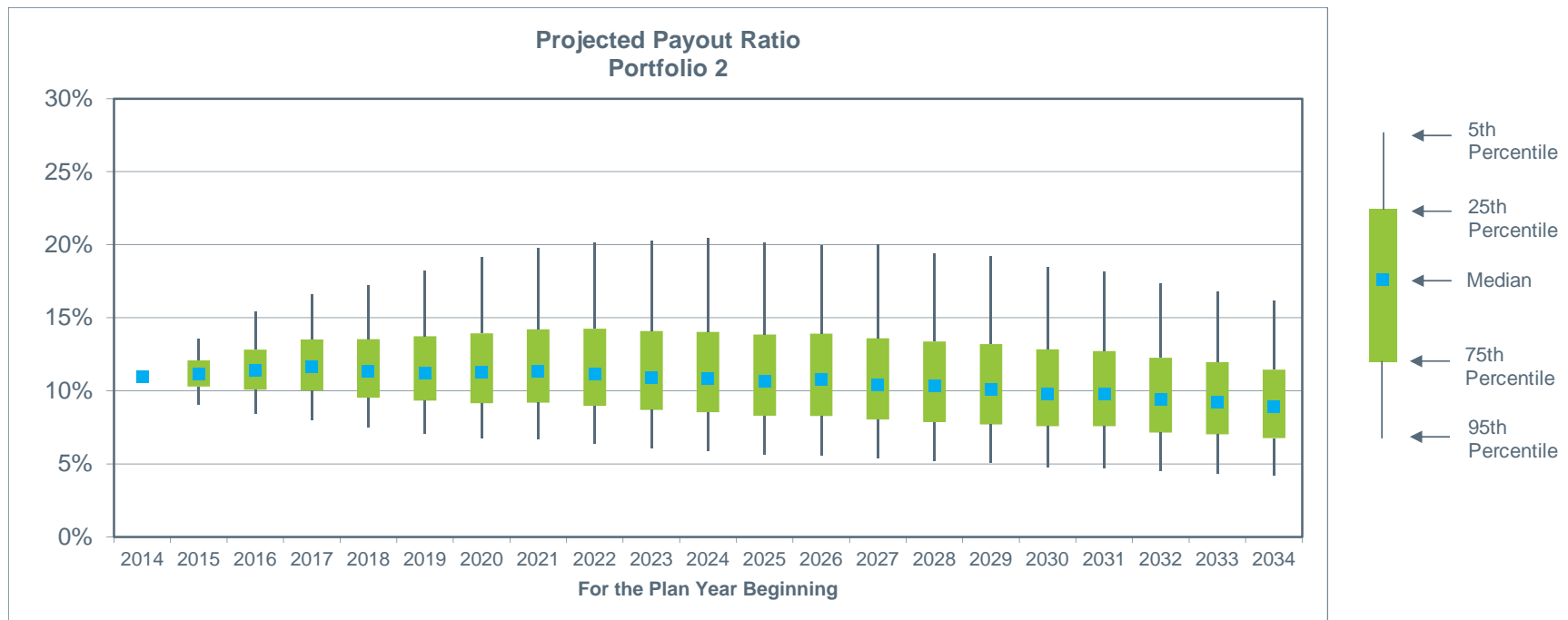
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Median	11%	11%	11%	12%	11%	11%	11%	12%	11%	11%	11%	11%	11%	11%	11%	10%	10%	10%	10%	10%	9%

Stochastic Analysis (continued)

Projected Payout Ratio (expected benefit payments/market value of assets); **Portfolio 2**

The graph below displays the range of possible payout ratios over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 2**. The results assume the current contribution policy remains unchanged for all projection years.

The median annual benefit payment as percentage of the market value of assets is expected to range between 9% and 12%. The worst-case scenario could reach 20% or higher.



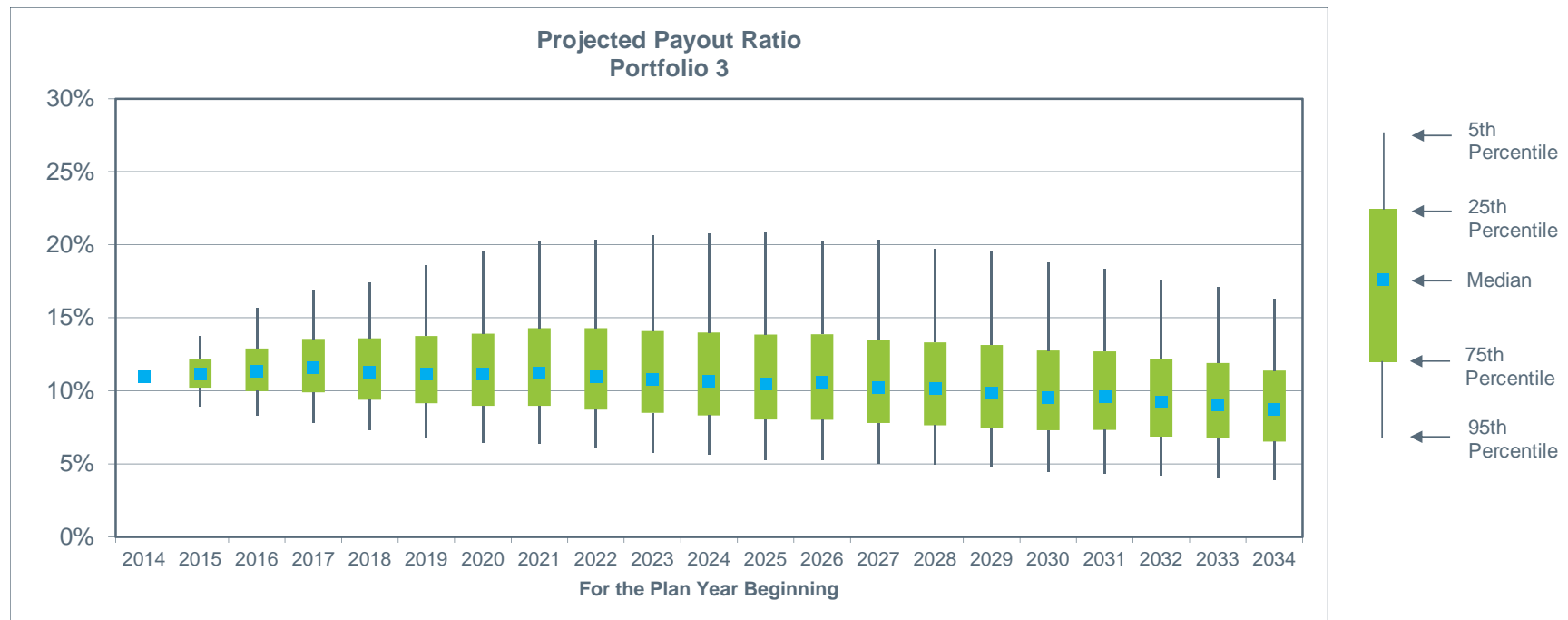
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
Median	11%	11%	11%	12%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	10%	10%	10%	10%	10%	9%	9%	9%

Stochastic Analysis (continued)

Projected Payout Ratio (expected benefit payments/market value of assets); **Portfolio 3**

The graph below displays the range of possible payout ratios over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 3**. The results assume the current contribution policy remains unchanged for all projection years.

The median annual benefit payment as percentage of the market value of assets is expected to range between 9% and 12%. The worst-case scenario could reach 21% or higher.



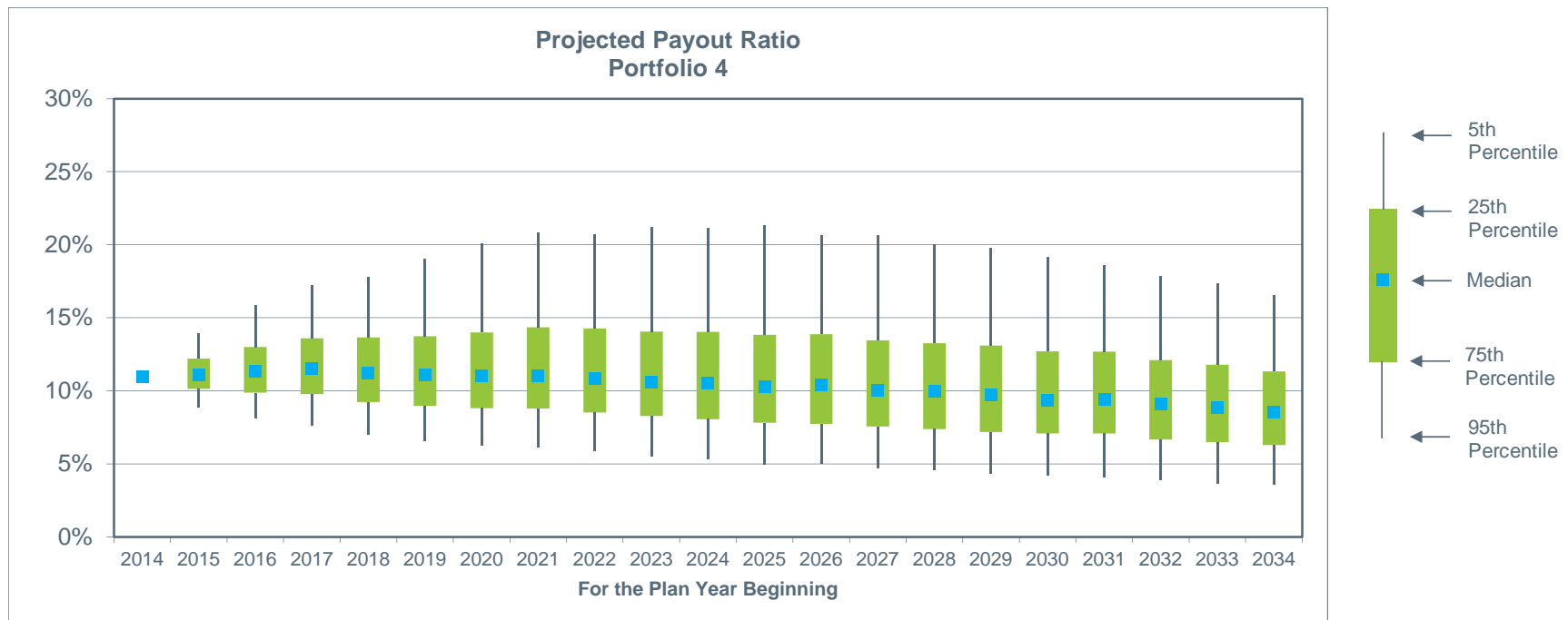
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Median	11%	11%	11%	12%	11%	11%	11%	11%	11%	11%	11%	10%	11%	10%	10%	10%	10%	10%	9%	9%	9%

Stochastic Analysis (continued)

Projected Payout Ratio (expected benefit payments/market value of assets); **Portfolio 4**

The graph below displays the range of possible payout ratios over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 4**. The results assume the current contribution policy remains unchanged for all projection years.

The median annual benefit payment as percentage of the market value of assets is expected to range between 9% and 12%. The worst-case scenario could reach 21% or higher.

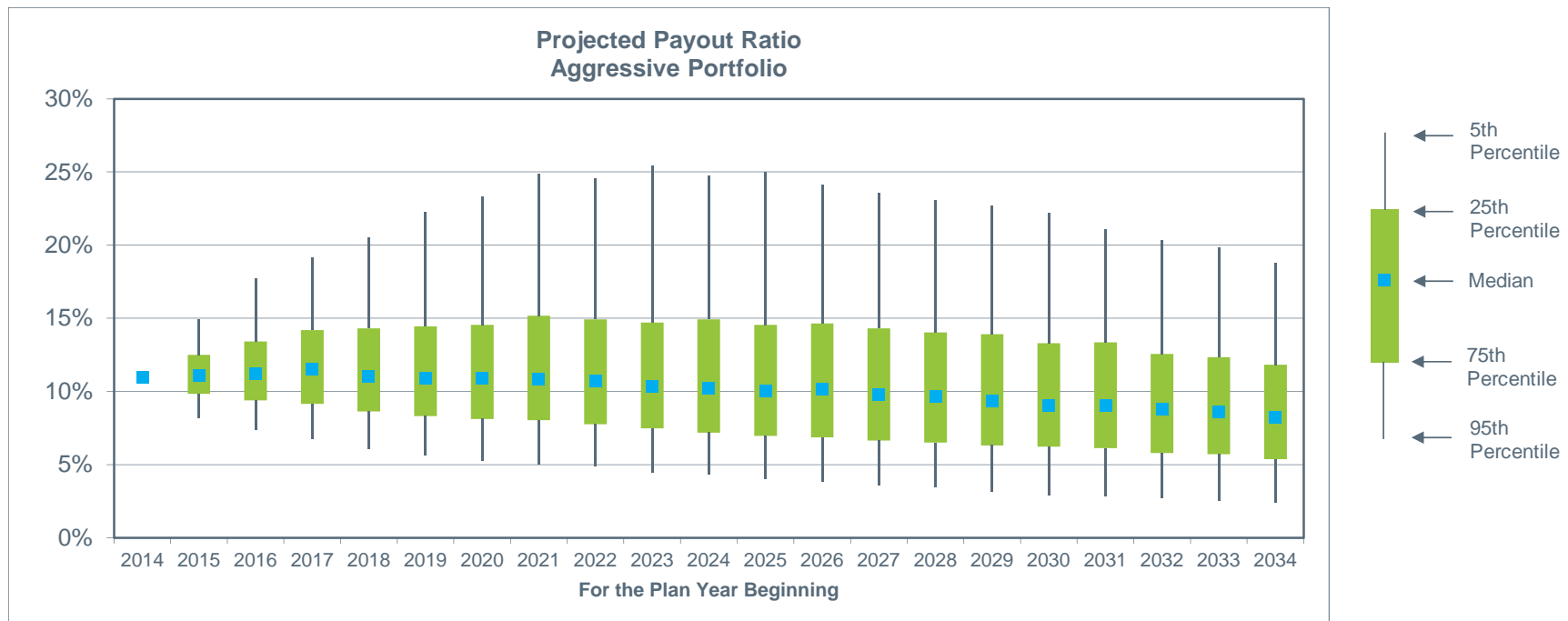


Stochastic Analysis (continued)

Projected Payout Ratio (expected benefit payments/market value of assets); **Aggressive Portfolio**

The graph below displays the range of possible payout ratios over the next twenty years, assuming the Plan's assets are allocated according to the **Aggressive Portfolio**. The results assume the current contribution policy remains unchanged for all projection years.

The median annual benefit payment as percentage of the market value of assets is expected to range between 8% and 12%. The worst-case scenario could reach 25% or higher.

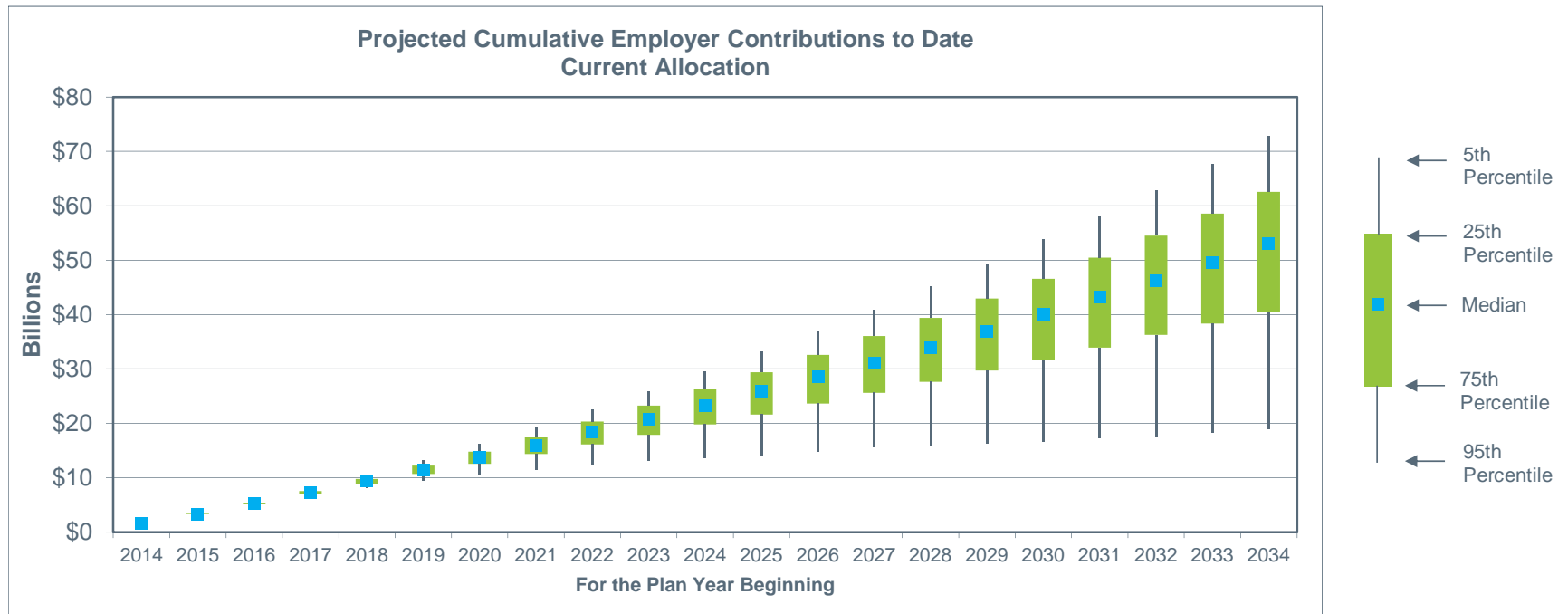


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Median	11%	11%	11%	12%	11%	11%	11%	11%	11%	10%	10%	10%	10%	10%	10%	9%	9%	9%	9%	9%	8%

Stochastic Analysis (continued)

Cumulative Contributions to Date; Current Allocation

The graph and table below show the range of projected cumulative contributions over the next twenty years, assuming the Plan's assets are allocated according to the **Current Allocation** (highlighted on the prior pages). The results assume the current contribution policy remains unchanged for all projection years.

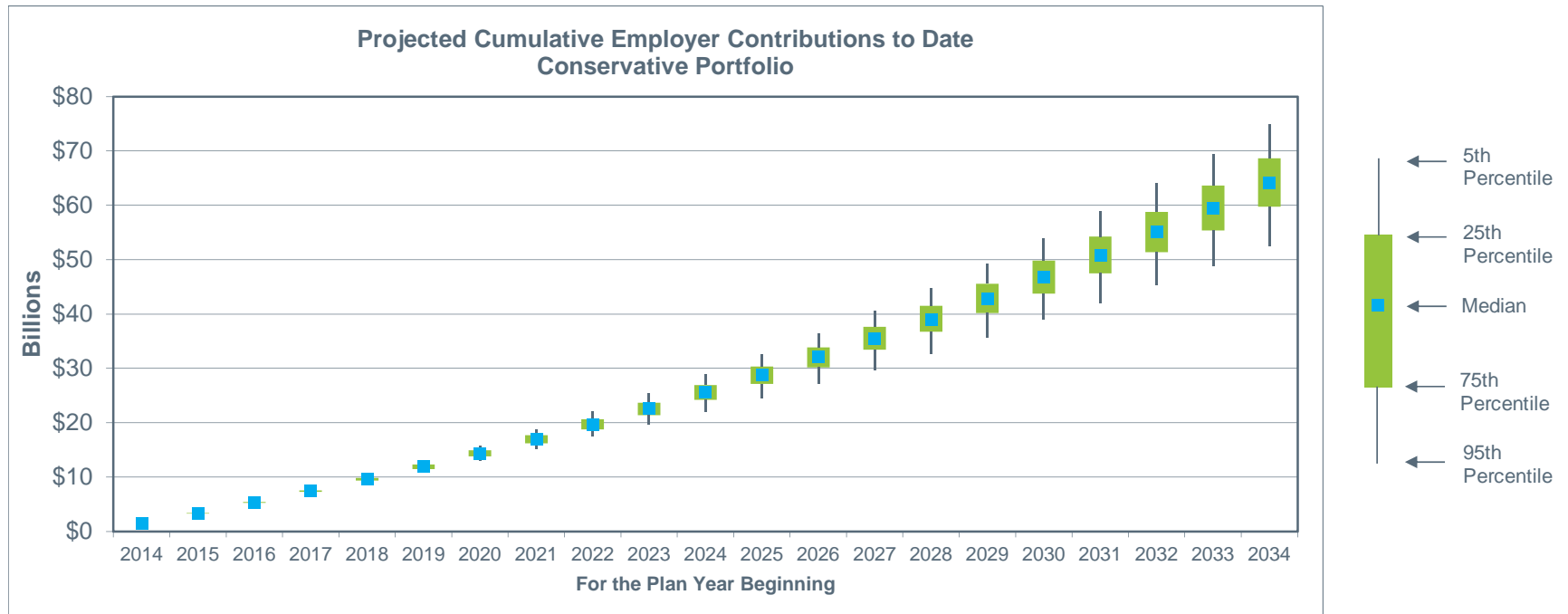


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
5th Percentile	\$1.5	\$3.4	\$5.5	\$7.9	\$10.4	\$13.2	\$16.2	\$19.3	\$22.5	\$25.9	\$29.5	\$33.2	\$37.0	\$40.8	\$45.1	\$49.3	\$53.8	\$58.1	\$62.8	\$67.6	\$72.7
25th Percentile	\$1.5	\$3.4	\$5.4	\$7.5	\$9.8	\$12.2	\$14.8	\$17.5	\$20.3	\$23.3	\$26.3	\$29.4	\$32.6	\$36.0	\$39.4	\$42.9	\$46.6	\$50.5	\$54.5	\$58.6	\$62.5
Median	\$1.5	\$3.3	\$5.3	\$7.3	\$9.4	\$11.5	\$13.7	\$16.0	\$18.3	\$20.7	\$23.2	\$25.9	\$28.5	\$31.2	\$34.0	\$36.9	\$40.0	\$43.2	\$46.2	\$49.6	\$53.1
75th Percentile	\$1.5	\$3.3	\$5.2	\$7.0	\$8.9	\$10.7	\$12.5	\$14.3	\$16.1	\$17.9	\$19.8	\$21.6	\$23.6	\$25.6	\$27.6	\$29.7	\$31.7	\$33.9	\$36.2	\$38.3	\$40.5
95th Percentile	\$1.5	\$3.3	\$5.0	\$6.6	\$8.1	\$9.4	\$10.4	\$11.4	\$12.3	\$13.1	\$13.6	\$14.1	\$14.7	\$15.6	\$16.0	\$16.3	\$16.7	\$17.3	\$17.6	\$18.3	\$18.9

Stochastic Analysis (continued)

Cumulative Contributions to Date; Conservative Portfolio

The graph and table below show the range of projected cumulative contributions over the next twenty years, assuming the Plan's assets are allocated according to the **Conservative Portfolio** (highlighted on the prior pages). The results assume the current contribution policy remains unchanged for all projection years.

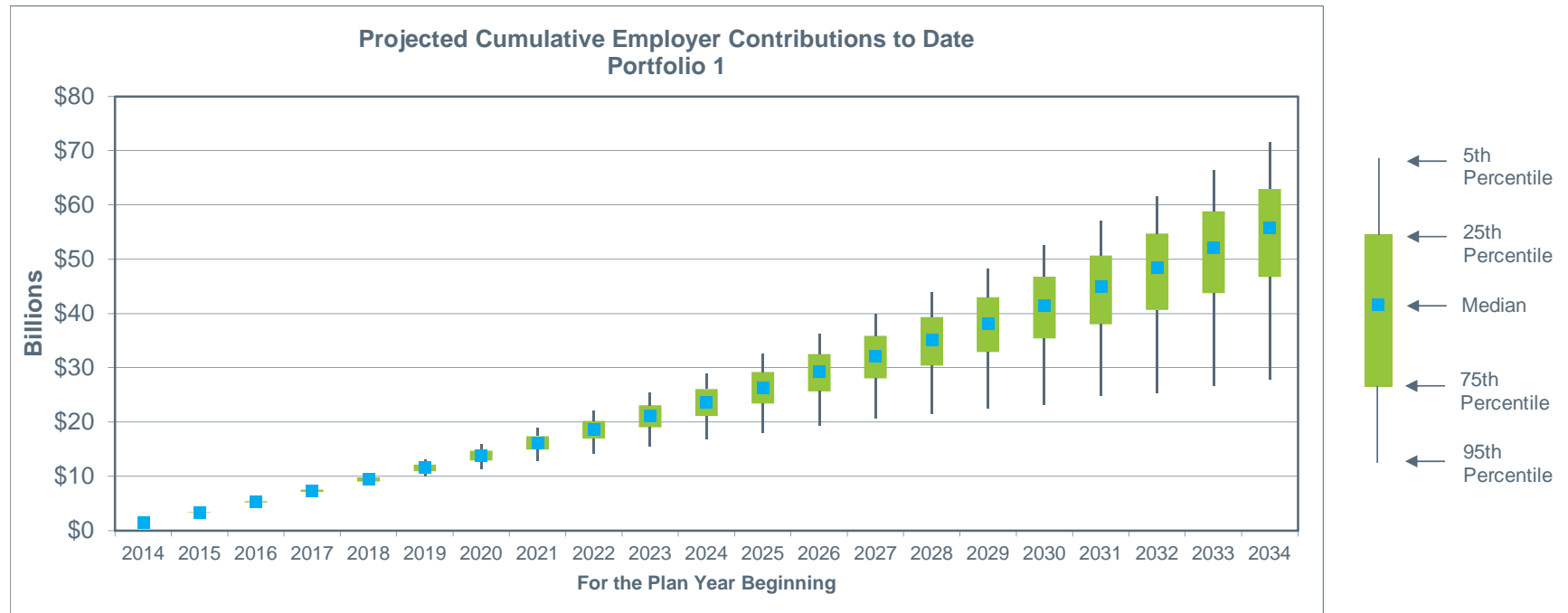


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
5th Percentile	\$1.5	\$3.4	\$5.5	\$7.8	\$10.2	\$12.9	\$15.8	\$18.8	\$22.1	\$25.4	\$28.9	\$32.7	\$36.5	\$40.5	\$44.7	\$49.2	\$53.9	\$58.9	\$64.0	\$69.3	\$74.9
25th Percentile	\$1.5	\$3.4	\$5.4	\$7.6	\$9.9	\$12.3	\$14.9	\$17.7	\$20.6	\$23.7	\$26.9	\$30.3	\$33.8	\$37.6	\$41.5	\$45.6	\$49.8	\$54.3	\$58.8	\$63.6	\$68.6
Median	\$1.5	\$3.3	\$5.3	\$7.4	\$9.6	\$11.9	\$14.4	\$17.0	\$19.7	\$22.6	\$25.6	\$28.8	\$32.1	\$35.5	\$39.0	\$42.8	\$46.7	\$50.8	\$55.0	\$59.5	\$64.1
75th Percentile	\$1.5	\$3.3	\$5.3	\$7.2	\$9.3	\$11.5	\$13.8	\$16.2	\$18.8	\$21.4	\$24.2	\$27.1	\$30.2	\$33.4	\$36.7	\$40.2	\$43.8	\$47.5	\$51.4	\$55.4	\$59.7
95th Percentile	\$1.5	\$3.3	\$5.2	\$7.0	\$9.0	\$11.0	\$13.0	\$15.2	\$17.4	\$19.7	\$22.0	\$24.5	\$27.1	\$29.8	\$32.7	\$35.7	\$38.9	\$42.0	\$45.2	\$48.7	\$52.6

Stochastic Analysis (continued)

Cumulative Contributions to Date; Portfolio 1

The graph and table below show the range of projected cumulative contributions over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 1** (highlighted on the prior pages). The results assume the current contribution policy remains unchanged for all projection years.

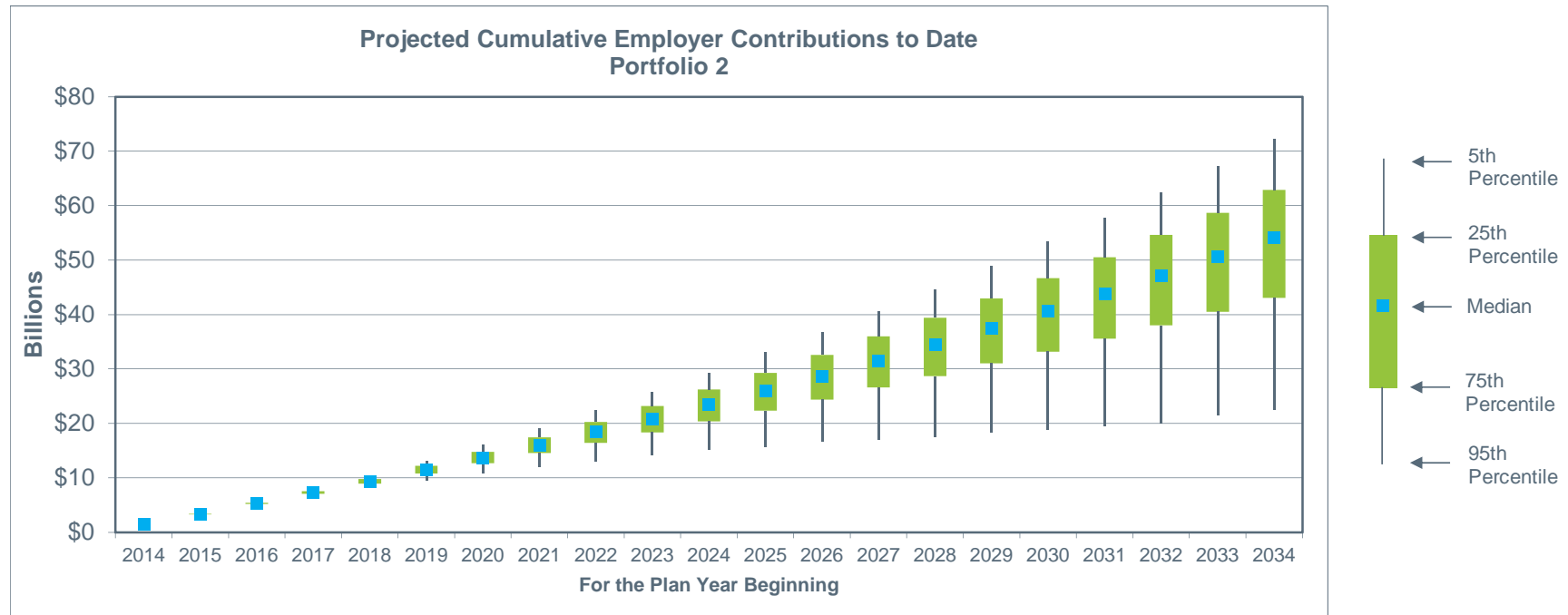


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
5th Percentile	\$1.5	\$3.4	\$5.5	\$7.8	\$10.3	\$13.0	\$15.9	\$18.9	\$22.1	\$25.4	\$28.9	\$32.5	\$36.3	\$40.0	\$44.0	\$48.2	\$52.5	\$57.0	\$61.6	\$66.4	\$71.6
25th Percentile	\$1.5	\$3.4	\$5.4	\$7.5	\$9.8	\$12.2	\$14.7	\$17.4	\$20.2	\$23.1	\$26.1	\$29.2	\$32.5	\$35.9	\$39.3	\$43.0	\$46.8	\$50.7	\$54.7	\$58.8	\$62.9
Median	\$1.5	\$3.3	\$5.3	\$7.3	\$9.4	\$11.6	\$13.8	\$16.2	\$18.6	\$21.1	\$23.7	\$26.4	\$29.2	\$32.1	\$35.1	\$38.1	\$41.5	\$44.9	\$48.5	\$52.1	\$55.8
75th Percentile	\$1.5	\$3.3	\$5.2	\$7.1	\$9.0	\$11.0	\$12.9	\$14.9	\$16.9	\$19.1	\$21.1	\$23.4	\$25.6	\$28.1	\$30.4	\$32.9	\$35.4	\$38.0	\$40.7	\$43.8	\$46.7
95th Percentile	\$1.5	\$3.3	\$5.1	\$6.8	\$8.4	\$9.9	\$11.4	\$12.8	\$14.2	\$15.5	\$16.9	\$18.0	\$19.3	\$20.7	\$21.5	\$22.5	\$23.1	\$24.8	\$25.3	\$26.7	\$27.8

Stochastic Analysis (continued)

Cumulative Contributions to Date; Portfolio 2

The graph and table below show the range of projected cumulative contributions over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 2** (highlighted on the prior pages). The results assume the current contribution policy remains unchanged for all projection years.

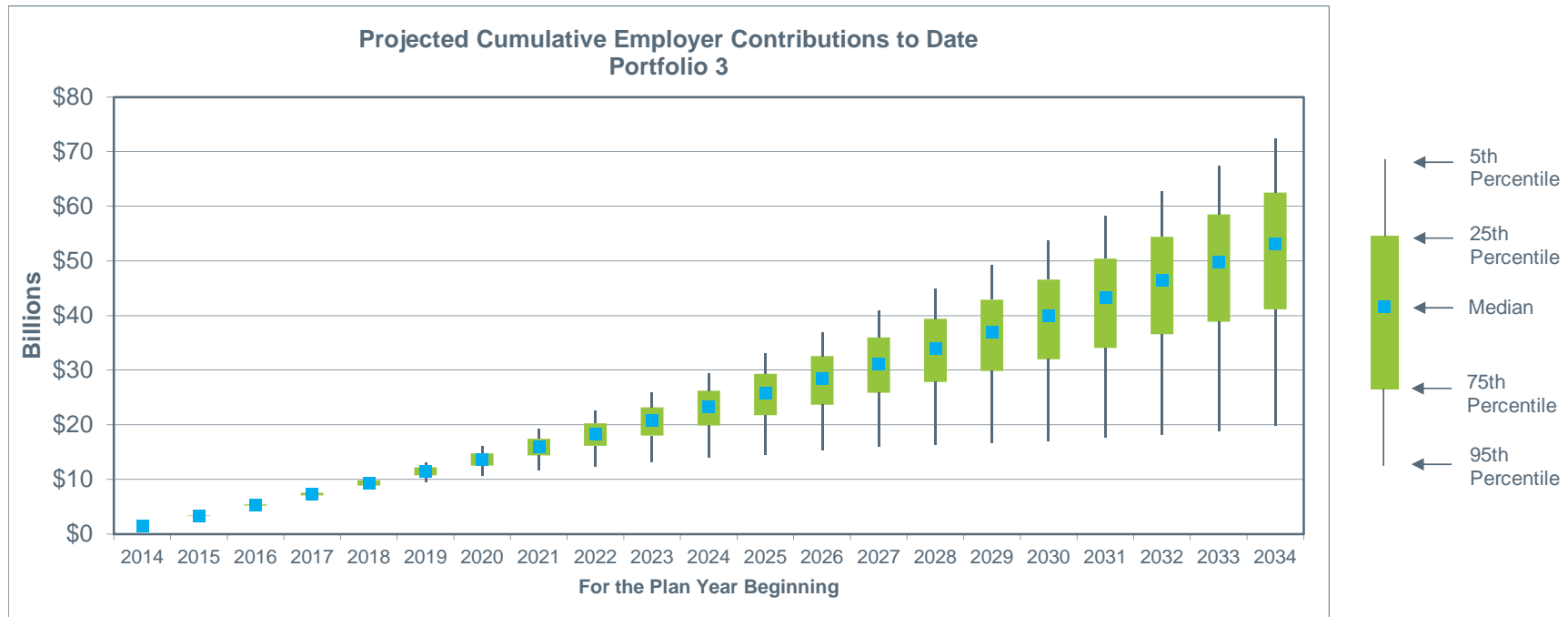


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
5th Percentile	\$1.5	\$3.4	\$5.5	\$7.8	\$10.4	\$13.1	\$16.1	\$19.1	\$22.4	\$25.8	\$29.3	\$33.0	\$36.7	\$40.6	\$44.5	\$48.9	\$53.4	\$57.7	\$62.4	\$67.3	\$72.3
25th Percentile	\$1.5	\$3.4	\$5.4	\$7.5	\$9.8	\$12.2	\$14.8	\$17.5	\$20.3	\$23.2	\$26.2	\$29.3	\$32.6	\$36.0	\$39.4	\$43.0	\$46.7	\$50.5	\$54.6	\$58.7	\$62.9
Median	\$1.5	\$3.3	\$5.3	\$7.3	\$9.4	\$11.5	\$13.7	\$16.0	\$18.5	\$20.9	\$23.4	\$26.0	\$28.7	\$31.5	\$34.5	\$37.4	\$40.6	\$43.8	\$47.1	\$50.6	\$54.1
75th Percentile	\$1.5	\$3.3	\$5.2	\$7.1	\$8.9	\$10.8	\$12.7	\$14.6	\$16.4	\$18.4	\$20.4	\$22.4	\$24.4	\$26.6	\$28.7	\$31.0	\$33.2	\$35.5	\$38.0	\$40.5	\$43.1
95th Percentile	\$1.5	\$3.3	\$5.0	\$6.7	\$8.2	\$9.6	\$10.8	\$12.0	\$13.0	\$14.2	\$15.1	\$15.7	\$16.7	\$17.1	\$17.6	\$18.4	\$18.8	\$19.5	\$20.0	\$21.5	\$22.4

Stochastic Analysis (continued)

Cumulative Contributions to Date; Portfolio 3

The graph and table below show the range of projected cumulative contributions over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 3** (highlighted on the prior pages). The results assume the current contribution policy remains unchanged for all projection years.

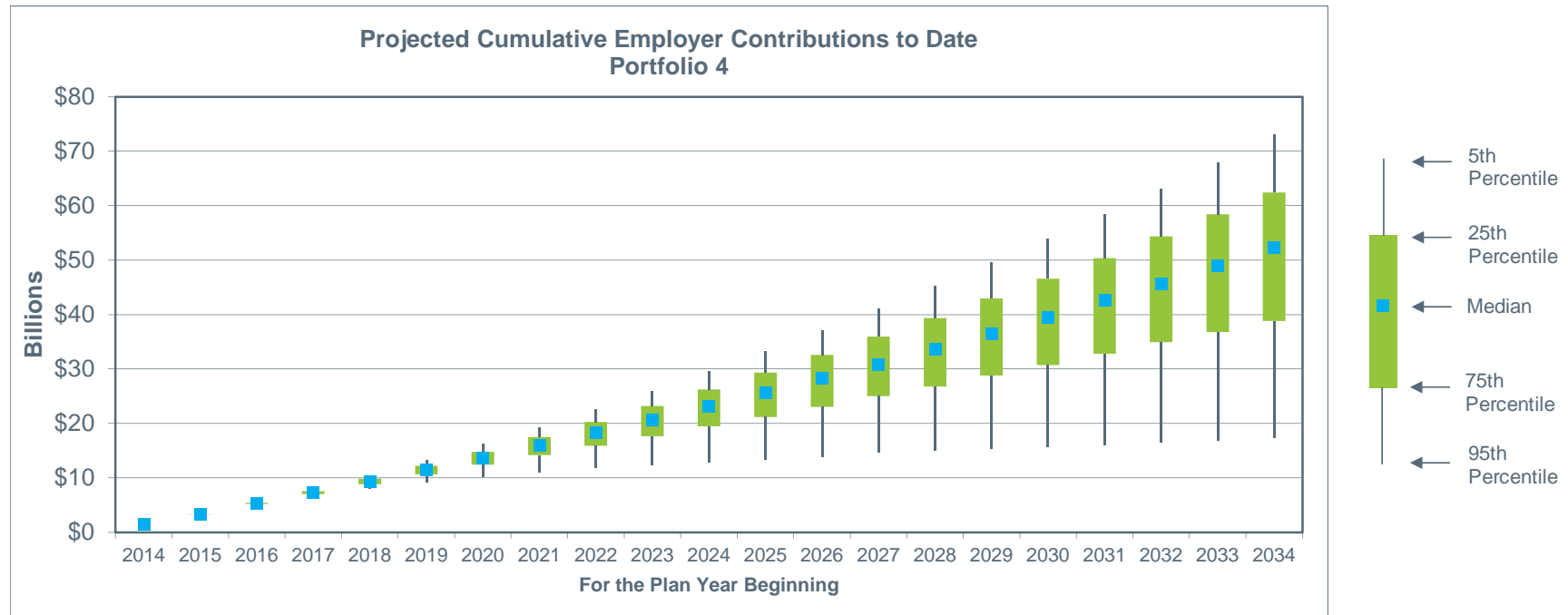


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
5th Percentile	\$1.5	\$3.4	\$5.5	\$7.9	\$10.4	\$13.2	\$16.2	\$19.2	\$22.5	\$25.9	\$29.4	\$33.1	\$36.9	\$40.9	\$44.9	\$49.2	\$53.7	\$58.2	\$62.7	\$67.4	\$72.5
25th Percentile	\$1.5	\$3.4	\$5.4	\$7.5	\$9.8	\$12.2	\$14.8	\$17.5	\$20.3	\$23.2	\$26.2	\$29.3	\$32.6	\$36.0	\$39.4	\$42.9	\$46.6	\$50.4	\$54.4	\$58.5	\$62.5
Median	\$1.5	\$3.3	\$5.3	\$7.3	\$9.4	\$11.5	\$13.7	\$16.0	\$18.3	\$20.8	\$23.2	\$25.9	\$28.5	\$31.2	\$34.0	\$36.9	\$39.9	\$43.2	\$46.4	\$49.8	\$53.1
75th Percentile	\$1.5	\$3.3	\$5.2	\$7.0	\$8.9	\$10.7	\$12.6	\$14.4	\$16.2	\$18.0	\$19.9	\$21.8	\$23.7	\$25.9	\$27.8	\$29.9	\$32.0	\$34.1	\$36.6	\$38.9	\$41.1
95th Percentile	\$1.5	\$3.3	\$5.0	\$6.6	\$8.1	\$9.4	\$10.6	\$11.6	\$12.5	\$13.3	\$14.0	\$14.4	\$15.3	\$16.0	\$16.3	\$16.6	\$17.0	\$17.6	\$18.2	\$18.8	\$20.0

Stochastic Analysis (continued)

Cumulative Contributions to Date; Portfolio 4

The graph and table below show the range of projected cumulative contributions over the next twenty years, assuming the Plan's assets are allocated according to **Portfolio 4** (highlighted on the prior pages). The results assume the current contribution policy remains unchanged for all projection years.

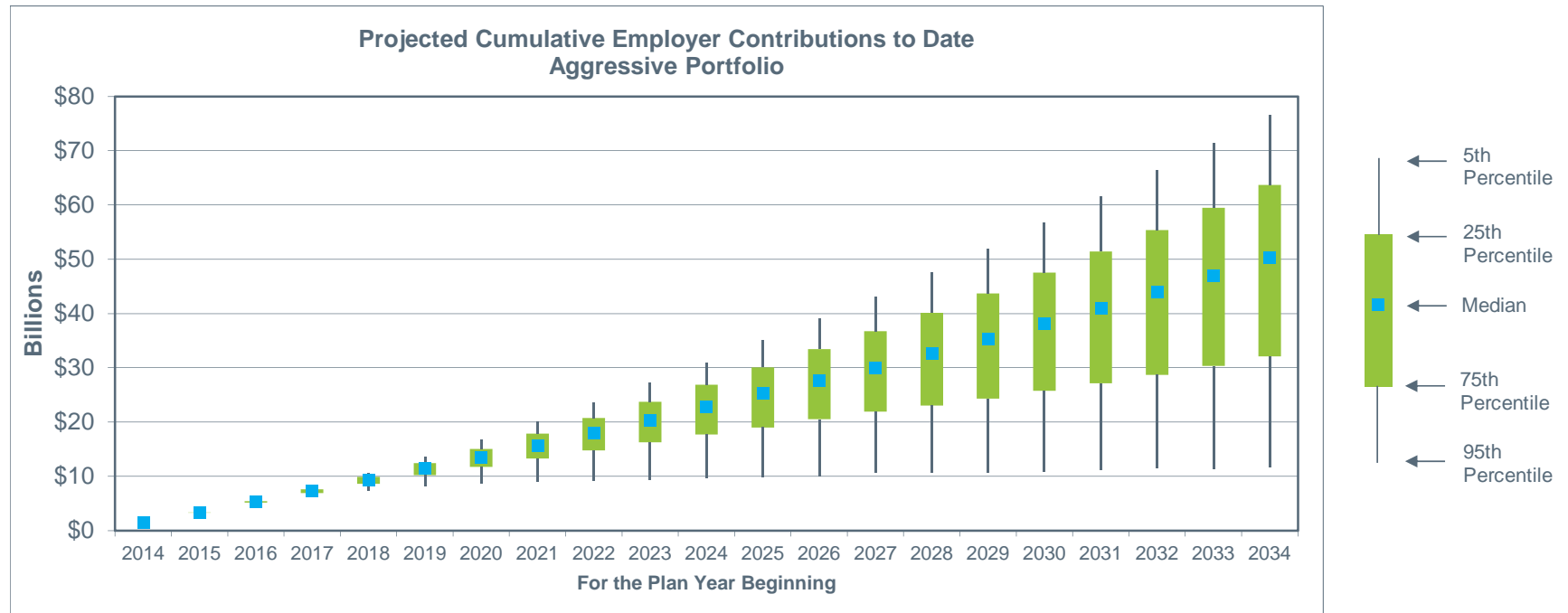


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
5th Percentile	\$1.5	\$3.4	\$5.5	\$7.9	\$10.4	\$13.2	\$16.2	\$19.2	\$22.5	\$25.9	\$29.4	\$33.1	\$36.9	\$40.9	\$44.9	\$49.2	\$53.7	\$58.2	\$62.7	\$67.4	\$72.5
25th Percentile	\$1.5	\$3.4	\$5.4	\$7.5	\$9.8	\$12.2	\$14.8	\$17.5	\$20.3	\$23.2	\$26.2	\$29.3	\$32.6	\$36.0	\$39.4	\$42.9	\$46.6	\$50.4	\$54.4	\$58.5	\$62.5
Median	\$1.5	\$3.3	\$5.3	\$7.3	\$9.4	\$11.5	\$13.7	\$16.0	\$18.3	\$20.8	\$23.2	\$25.9	\$28.5	\$31.2	\$34.0	\$36.9	\$39.9	\$43.2	\$46.4	\$49.8	\$53.1
75th Percentile	\$1.5	\$3.3	\$5.2	\$7.0	\$8.9	\$10.7	\$12.6	\$14.4	\$16.2	\$18.0	\$19.9	\$21.8	\$23.7	\$25.9	\$27.8	\$29.9	\$32.0	\$34.1	\$36.6	\$38.9	\$41.1
95th Percentile	\$1.5	\$3.3	\$5.0	\$6.6	\$8.1	\$9.4	\$10.6	\$11.6	\$12.5	\$13.3	\$14.0	\$14.4	\$15.3	\$16.0	\$16.3	\$16.6	\$17.0	\$17.6	\$18.2	\$18.8	\$20.0

Stochastic Analysis (continued)

Cumulative Contributions to Date; Aggressive Portfolio

The graph and table below show the range of projected cumulative contributions over the next twenty years, assuming the Plan's assets are allocated according to the **Aggressive Portfolio** (highlighted on the prior pages). The results assume the current contribution policy remains unchanged for all projection years.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
5th Percentile	\$1.5	\$3.4	\$5.6	\$8.0	\$10.6	\$13.6	\$16.8	\$20.1	\$23.6	\$27.2	\$31.0	\$35.0	\$39.1	\$43.2	\$47.5	\$51.9	\$56.7	\$61.5	\$66.5	\$71.4	\$76.6
25th Percentile	\$1.5	\$3.4	\$5.4	\$7.6	\$9.9	\$12.4	\$15.1	\$17.9	\$20.7	\$23.8	\$26.9	\$30.1	\$33.4	\$36.8	\$40.1	\$43.7	\$47.6	\$51.4	\$55.4	\$59.5	\$63.7
Median	\$1.5	\$3.3	\$5.3	\$7.3	\$9.3	\$11.4	\$13.6	\$15.7	\$18.0	\$20.3	\$22.8	\$25.2	\$27.6	\$30.0	\$32.6	\$35.4	\$38.2	\$41.0	\$44.0	\$47.0	\$50.4
75th Percentile	\$1.5	\$3.3	\$5.1	\$6.9	\$8.6	\$10.2	\$11.8	\$13.3	\$14.8	\$16.3	\$17.7	\$19.0	\$20.5	\$21.9	\$23.1	\$24.3	\$25.8	\$27.2	\$28.7	\$30.3	\$32.1
95th Percentile	\$1.5	\$3.2	\$4.9	\$6.3	\$7.4	\$8.2	\$8.7	\$9.0	\$9.3	\$9.4	\$9.6	\$9.8	\$10.0	\$10.6	\$10.7	\$10.7	\$10.9	\$11.1	\$11.4	\$11.5	\$11.7

Stochastic Analysis (continued)

Employer Contributions (as a weighted average percentage of salary)

The tables below show the range of required employer contributions (as a weighted average percentage of salary) assuming the seven different asset mixes highlighted on the prior pages. The results assume the current contribution policy remains unchanged for all projection years.

5 Years	Required Employer Contribution for Plan Year Beginning 2019				
	5th	25th	50th	75th	95th
Current Allocation	42%	36%	31%	26%	17%
Conservative Portfolio	40%	36%	34%	31%	28%
Portfolio 1	41%	36%	32%	27%	21%
Portfolio 2	42%	36%	31%	27%	19%
Portfolio 3	42%	36%	31%	26%	17%
Portfolio 4	42%	36%	31%	26%	16%
Aggressive Portfolio	45%	37%	31%	23%	10%

10 Years	Required Employer Contribution for Plan Year Beginning 2024				
	5th	25th	50th	75th	95th
Current Allocation	50%	40%	31%	22%	3%
Conservative Portfolio	49%	42%	38%	33%	26%
Portfolio 1	48%	40%	33%	26%	13%
Portfolio 2	49%	39%	32%	24%	9%
Portfolio 3	50%	40%	31%	23%	3%
Portfolio 4	50%	40%	31%	22%	1%
Aggressive Portfolio	53%	40%	30%	17%	0%

20 Years	Required Employer Contribution for Plan Year Beginning 2034				
	5th	25th	50th	75th	95th
Current Allocation	55%	43%	32%	20%	0%
Conservative Portfolio	57%	49%	43%	38%	30%
Portfolio 1	54%	44%	35%	25%	0%
Portfolio 2	54%	43%	33%	22%	0%
Portfolio 3	54%	43%	32%	20%	0%
Portfolio 4	55%	43%	32%	18%	0%
Aggressive Portfolio	58%	44%	30%	2%	0%

Stochastic Analysis (continued)

Drawing Inferences

The tables below compare the projected market funded ratios five, ten, and twenty years from now, under the median (50th percentile), worst-case (5th percentile), and best-case (95th percentile) scenarios, assuming the seven different asset mixes highlighted on the prior pages. The table also displays for comparative purposes the median, peak, and trough projected payout ratios and cumulative employer contributions for the seven asset mixes being examined.

5 Years	Market Funded Ratio in Year 5			Cumulative Employer Contributions in Year 5 (Billions)			Payout Ratios		
	50th	5th	95th	50th	5th	95th	Year 5 Median	Years 1 to 5	
								Peak	Trough
Current Allocation	61%	37%	98%	\$11.5	\$13.2	\$9.4	11%	19%	7%
Conservative Portfolio	53%	42%	68%	\$11.9	\$12.9	\$11.0	13%	17%	10%
Portfolio 1	59%	40%	87%	\$11.6	\$13.0	\$9.9	11%	17%	8%
Portfolio 2	60%	38%	94%	\$11.5	\$13.1	\$9.6	11%	18%	7%
Portfolio 3	61%	37%	98%	\$11.5	\$13.2	\$9.4	11%	19%	7%
Portfolio 4	61%	37%	102%	\$11.5	\$13.2	\$9.4	11%	19%	7%
Aggressive Portfolio	62%	31%	120%	\$11.4	\$13.6	\$8.2	11%	22%	6%

10 Years	Market Funded Ratio in Year 10			Cumulative Employer Contributions in Year 10 (Billions)			Payout Ratios		
	50th	5th	95th	50th	5th	95th	Year 10 Median	Years 1 to 10	
								Peak	Trough
Current Allocation	62%	33%	118%	\$23.2	\$29.5	\$13.6	11%	21%	6%
Conservative Portfolio	50%	36%	68%	\$25.6	\$28.9	\$22.0	13%	20%	9%
Portfolio 1	60%	35%	99%	\$23.7	\$28.9	\$16.9	11%	20%	6%
Portfolio 2	62%	34%	109%	\$23.4	\$29.3	\$15.1	11%	20%	6%
Portfolio 3	62%	33%	116%	\$23.2	\$29.4	\$14.0	11%	21%	6%
Portfolio 4	63%	33%	122%	\$23.2	\$29.4	\$14.0	11%	21%	5%
Aggressive Portfolio	64%	28%	151%	\$22.8	\$31.0	\$9.6	10%	25%	4%

20 Years	Market Funded Ratio in Year 20			Cumulative Employer Contributions in Year 20 (Billions)			Payout Ratios		
	50th	5th	95th	50th	5th	95th	Year 20 Median	Years 1 to 20	
								Peak	Trough
Current Allocation	69%	38%	153%	\$53.1	\$72.7	\$18.9	9%	21%	4%
Conservative Portfolio	52%	39%	70%	\$64.1	\$74.9	\$52.6	11%	20%	8%
Portfolio 1	65%	41%	116%	\$55.8	\$71.6	\$27.8	9%	20%	5%
Portfolio 2	67%	39%	136%	\$54.1	\$72.3	\$22.4	9%	20%	4%
Portfolio 3	68%	38%	149%	\$53.1	\$72.5	\$20.0	9%	21%	4%
Portfolio 4	70%	38%	162%	\$53.1	\$72.5	\$20.0	9%	21%	4%
Aggressive Portfolio	72%	33%	242%	\$50.4	\$76.6	\$11.7	8%	25%	2%

Appendix 1: Sensitivity Analysis: “Effect of Higher Volatility”

This section provides a sensitivity analysis of the original stochastic projections by assuming the risk (as measured by standard deviation) of each asset class is doubled. These modified assumptions are outlined in the table below, compared to the original values:

Asset Class	Arithmetic Return Assumption	Standard Deviation Assumption	Standard Deviation Assumption Doubled
Global Equity	7.80	18.35	36.70
SERS Custom Fixed Income	4.13	6.66	13.32
Long-Biased L/S Equity	7.25	13.00	26.00
Private Equity	10.50	26.00	52.00
SERS Custom Real Estate	7.41	13.64	27.28
Cash Equivalents	2.25	3.00	6.00

RVK supports the recommendations based on the original assumptions shown in the Stochastic Analysis section of this report. However, this stress-testing illustrates that potential increased capital market volatility does not change the asset allocation recommendations, based on the current status of the Plan. Instead it simply widens the range of potential results, exacerbating the potential best and worst-case scenarios.

Appendix 1: Sensitivity Analysis: “Effect of Higher Volatility” (continued)

Projected Market Funded Ratio and Maximum 1 Year Investment Loss (market value of assets/actuarial accrued liability)

The tables below show the probability that the Plan will be at various funding levels for each of the seven different asset mixes highlighted on the prior pages. The tables also illustrate the maximum 1 year investment loss each portfolio is expected to experience during the given time period. The results assume the current contribution policy remains unchanged for all projection years.

5 Years	Probability of Full Funding in 2019	Probability of < 61% (Current) Funding in 2019	Probability of < 50% Funding in 2019	Maximum 1 Year Investment Loss
Current Allocation	25%	50%	41%	-64%
Conservative Portfolio	5%	63%	43%	-44%
Portfolio 1	22%	51%	41%	-59%
Portfolio 2	24%	50%	41%	-62%
Portfolio 3	25%	50%	41%	-64%
Portfolio 4	26%	50%	41%	-65%
Aggressive Portfolio	30%	50%	42%	-74%

10 Years	Probability of Full Funding in 2024	Probability of < 61% (Current) Funding in 2024	Probability of < 50% Funding in 2024	Maximum 1 Year Investment Loss
Current Allocation	31%	50%	44%	-64%
Conservative Portfolio	8%	66%	52%	-44%
Portfolio 1	28%	52%	45%	-59%
Portfolio 2	30%	51%	44%	-62%
Portfolio 3	31%	51%	44%	-64%
Portfolio 4	32%	50%	44%	-65%
Aggressive Portfolio	35%	50%	45%	-74%

20 Years	Probability of Full Funding in 2034	Probability of < 61% (Current) Funding in 2034	Probability of < 50% Funding in 2034	Maximum 1 Year Investment Loss
Current Allocation	39%	44%	36%	-73%
Conservative Portfolio	8%	65%	50%	-54%
Portfolio 1	34%	47%	38%	-69%
Portfolio 2	37%	45%	37%	-71%
Portfolio 3	38%	45%	37%	-73%
Portfolio 4	40%	44%	36%	-75%
Aggressive Portfolio	42%	44%	38%	-83%

Appendix 1: Sensitivity Analysis: “Effect of Higher Volatility” (continued)

Drawing Inferences

The tables below compare the projected market funded ratios five, ten, and twenty years from now, under the median (50th percentile), worst-case (5th percentile), and best-case (95th percentile) scenarios, assuming the seven different asset mixes highlighted on the prior pages. The table also displays for comparative purposes the median, peak, and trough projected payout ratios and cumulative employer contributions for the seven asset mixes being examined.

5 Years	Market Funded Ratio in Year 5			Cumulative Employer Contributions in Year 5 (Billions)			Payout Ratios		
	50th	5th	95th				Year 5 Median	Years 1 to 5	
				50th	5th	95th		Peak	Trough
Current Allocation	61%	15%	209%	\$11.4	\$12.9	\$5.5	11%	49%	3%
Conservative Portfolio	54%	26%	100%	\$11.8	\$12.5	\$10.3	12%	29%	6%
Portfolio 1	60%	18%	175%	\$11.5	\$12.8	\$6.2	11%	43%	3%
Portfolio 2	60%	16%	194%	\$11.4	\$12.8	\$5.7	11%	47%	3%
Portfolio 3	61%	16%	205%	\$11.4	\$12.9	\$5.5	11%	49%	3%
Portfolio 4	61%	15%	216%	\$11.4	\$12.9	\$5.5	11%	51%	3%
Aggressive Portfolio	62%	10%	272%	\$11.3	\$13.2	\$4.4	11%	73%	2%

10 Years	Market Funded Ratio in Year 10			Cumulative Employer Contributions in Year 10 (Billions)			Payout Ratios		
	50th	5th	95th				Year 10 Median	Years 1 to 10	
				50th	5th	95th		Peak	Trough
Current Allocation	60%	10%	368%	\$23.1	\$29.7	\$5.8	11%	79%	1%
Conservative Portfolio	49%	19%	115%	\$25.4	\$28.4	\$15.6	14%	41%	5%
Portfolio 1	58%	12%	279%	\$23.7	\$29.4	\$6.6	12%	65%	2%
Portfolio 2	59%	11%	329%	\$23.3	\$29.6	\$6.0	11%	73%	2%
Portfolio 3	60%	10%	358%	\$23.2	\$29.7	\$5.8	11%	78%	2%
Portfolio 4	60%	10%	388%	\$23.2	\$29.7	\$5.8	11%	82%	1%
Aggressive Portfolio	60%	6%	551%	\$22.9	\$30.8	\$4.8	11%	100%	1%

20 Years	Market Funded Ratio in Year 20			Cumulative Employer Contributions in Year 20 (Billions)			Payout Ratios		
	50th	5th	95th				Year 20 Median	Years 1 to 20	
				50th	5th	95th		Peak	Trough
Current Allocation	71%	18%	642%	\$49.4	\$72.9	\$6.1	9%	79%	1%
Conservative Portfolio	50%	23%	115%	\$63.8	\$70.4	\$25.0	12%	44%	4%
Portfolio 1	65%	20%	423%	\$53.0	\$71.9	\$7.4	9%	65%	1%
Portfolio 2	68%	19%	542%	\$50.9	\$72.5	\$6.7	9%	73%	1%
Portfolio 3	70%	18%	616%	\$50.1	\$72.9	\$6.3	9%	78%	1%
Portfolio 4	71%	18%	694%	\$50.1	\$72.9	\$6.3	8%	84%	1%
Aggressive Portfolio	74%	15%	1104%	\$48.8	\$75.6	\$5.0	8%	100%	0%

Appendix 2: Sensitivity Analysis: “Effect of Higher Correlations”

This section provides a sensitivity analysis of the original stochastic projections by assuming that all asset classes are perfectly positively correlated (i.e. correlation = 1.00). A correlation matrix reflecting these modified assumptions is provided below:

	Global Equity	SERS Custom Fixed Income	Long-Biased L/S Equity	Private Equity	SERS Custom Real Estate	Cash Equivalents
Global Equity	1.00	1.00	1.00	1.00	1.00	1.00
SERS Custom Fixed Income	1.00	1.00	1.00	1.00	1.00	1.00
Long-Biased L/S Equity	1.00	1.00	1.00	1.00	1.00	1.00
Private Equity	1.00	1.00	1.00	1.00	1.00	1.00
SERS Custom Real Estate	1.00	1.00	1.00	1.00	1.00	1.00
Cash Equivalents	1.00	1.00	1.00	1.00	1.00	1.00

RVK supports the recommendations based on the original assumptions shown in the Stochastic Analysis section of this report. However, this stress-testing illustrates that converging correlations across capital markets does not change the asset allocation recommendations, based on the current status of the Plan. Instead it simply widens the range of potential results, indicating higher risk for all asset mixes given the dampened effects of total fund diversification.

Appendix 2: Sensitivity Analysis: “Effect of Higher Correlations” (continued)

Projected Market Funded Ratio and Maximum 1 Year Investment Loss (market value of assets/actuarial accrued liability)

The tables below show the probability that the Plan will be at various funding levels for each of the seven different asset mixes highlighted on the prior pages. The tables also illustrate the maximum 1 year investment loss each portfolio is expected to experience during the given time period. The results assume the current contribution policy remains unchanged for all projection years.

5 Years	Probability of Full Funding in 2019	Probability of < 61% (Current) Funding in 2019	Probability of < 50% Funding in 2019	Maximum 1 Year Investment Loss
Current Allocation	9%	52%	33%	-40%
Conservative Portfolio	0%	75%	37%	-24%
Portfolio 1	5%	55%	33%	-36%
Portfolio 2	7%	53%	33%	-38%
Portfolio 3	9%	52%	33%	-39%
Portfolio 4	10%	51%	33%	-41%
Aggressive Portfolio	15%	50%	34%	-48%

10 Years	Probability of Full Funding in 2024	Probability of < 61% (Current) Funding in 2024	Probability of < 50% Funding in 2024	Maximum 1 Year Investment Loss
Current Allocation	16%	52%	37%	-40%
Conservative Portfolio	0%	78%	52%	-24%
Portfolio 1	11%	56%	40%	-36%
Portfolio 2	13%	54%	38%	-38%
Portfolio 3	15%	52%	38%	-39%
Portfolio 4	17%	51%	37%	-41%
Aggressive Portfolio	22%	50%	38%	-48%

20 Years	Probability of Full Funding in 2034	Probability of < 61% (Current) Funding in 2034	Probability of < 50% Funding in 2034	Maximum 1 Year Investment Loss
Current Allocation	21%	45%	29%	-49%
Conservative Portfolio	0%	78%	47%	-31%
Portfolio 1	14%	49%	31%	-44%
Portfolio 2	18%	46%	30%	-47%
Portfolio 3	21%	45%	29%	-49%
Portfolio 4	23%	44%	29%	-50%
Aggressive Portfolio	30%	42%	30%	-58%

Appendix 2: Sensitivity Analysis: “Effect of Higher Correlations” (continued)

Drawing Inferences

The tables below compare the projected market funded ratios five, ten, and twenty years from now, under the median (50th percentile), worst-case (5th percentile), and best-case (95th percentile) scenarios, assuming the seven different asset mixes highlighted on the prior pages. The table also displays for comparative purposes the median, peak, and trough projected payout ratios and cumulative employer contributions for the seven asset mixes being examined.

5 Years	Market Funded Ratio in Year 5			Cumulative Employer Contributions in Year 5 (Billions)			Payout Ratios		
	50th	5th	95th	50th	5th	95th	Year 5 Median	Years 1 to 5	
								Peak	Trough
Current Allocation	60%	31%	111%	\$11.6	\$12.8	\$8.9	11%	23%	6%
Conservative Portfolio	54%	38%	73%	\$11.9	\$12.3	\$11.3	13%	19%	9%
Portfolio 1	58%	33%	100%	\$11.7	\$12.7	\$9.6	12%	22%	6%
Portfolio 2	59%	31%	107%	\$11.6	\$12.7	\$9.2	11%	23%	6%
Portfolio 3	60%	31%	110%	\$11.6	\$12.8	\$9.0	11%	23%	6%
Portfolio 4	60%	30%	114%	\$11.6	\$12.8	\$9.0	11%	24%	6%
Aggressive Portfolio	61%	27%	131%	\$11.5	\$13.0	\$7.7	11%	27%	5%

10 Years	Market Funded Ratio in Year 10			Cumulative Employer Contributions in Year 10 (Billions)			Payout Ratios		
	50th	5th	95th	50th	5th	95th	Year 10 Median	Years 1 to 10	
								Peak	Trough
Current Allocation	59%	26%	142%	\$23.7	\$29.2	\$11.1	11%	28%	4%
Conservative Portfolio	49%	31%	76%	\$25.6	\$27.7	\$22.1	14%	23%	8%
Portfolio 1	57%	27%	122%	\$24.1	\$28.8	\$13.7	12%	27%	5%
Portfolio 2	58%	26%	133%	\$23.8	\$29.0	\$12.1	11%	28%	5%
Portfolio 3	59%	26%	140%	\$23.7	\$29.2	\$11.2	11%	28%	4%
Portfolio 4	60%	25%	148%	\$23.7	\$29.2	\$11.2	11%	29%	4%
Aggressive Portfolio	61%	22%	185%	\$23.2	\$30.0	\$8.6	11%	33%	3%

20 Years	Market Funded Ratio in Year 20			Cumulative Employer Contributions in Year 20 (Billions)			Payout Ratios		
	50th	5th	95th	50th	5th	95th	Year 20 Median	Years 1 to 20	
								Peak	Trough
Current Allocation	65%	31%	173%	\$54.6	\$70.5	\$13.1	9%	29%	3%
Conservative Portfolio	51%	34%	76%	\$64.4	\$68.7	\$52.6	12%	24%	7%
Portfolio 1	62%	32%	136%	\$56.9	\$69.7	\$17.8	10%	27%	4%
Portfolio 2	64%	31%	156%	\$55.6	\$70.2	\$14.8	9%	28%	3%
Portfolio 3	65%	31%	170%	\$54.8	\$70.4	\$13.4	9%	28%	3%
Portfolio 4	66%	31%	185%	\$54.8	\$70.4	\$13.4	9%	29%	3%
Aggressive Portfolio	70%	28%	260%	\$51.8	\$72.5	\$10.1	9%	33%	2%

Appendix 3: Assumptions and Methods

Actuarial Valuation Assumptions and Methods: At the beginning of each projection year, an actuarial valuation is performed to determine employer contributions. The assumptions used in the December 31, 2014 actuarial valuation prepared by the Hay Group were used in all years. These methods and assumptions are summarized below:

Actuarial Cost Method	Entry-Age Normal (level % of pay, replacement life). Funding policies and methods are described on pages 59-60 of the December 31, 2014 actuarial valuation prepared by the Hay Group.
Liability Discount Rate	7.50% per year, compounded annually.
Future Pay Increases	Future pay increases as described on pages 56-57 of the December 31, 2014 actuarial valuation prepared by the Hay Group. Pay increases include a 3.05% base wage inflation rate.
Retirement	Rates of retirement as described on pages 53, and 55-58 of the December 31, 2014 actuarial valuation prepared by the Hay Group.
Mortality	Rates of mortality as described on pages 52 and 54 of the December 31, 2014 actuarial valuation prepared by the Hay Group.
Disability	Rates of disability as described on page 54 of the December 31, 2014 actuarial valuation prepared by the Hay Group.
Withdrawal	Rates of withdrawal as described on pages 54-55 of the December 31, 2014 actuarial valuation prepared by the Hay Group.
Asset Valuation Method	5-Year smoothing of actual versus expected returns. The asset valuation method is described on page 59 of the December 31, 2014 actuarial valuation prepared by the Hay Group.

Appendix 3: Assumptions and Methods (continued)

Actuarial Valuation Assumptions and Methods: (continued)

Contribution Policy

For all fiscal years of the projection, employer contributions are assumed to equal the sum of (1) gross normal cost, less expected employee contributions, (2) the fresh start amortization of the December 31, 2009 unfunded liability over a 30-year period beginning July 1, 2010, (3) the amortization of the change in liability due to Act 2010-120 over a 30-year period beginning July 1, 2011, and (4) The amortization of changes in liability due to actual experience differing from assumed experience after December 31, 2009 over 30-year periods. All amortizations of unfunded liability are level dollar amounts. Calculated employer contributions were adjusted by contribution collars provided by Act 2010-120, if applicable.

Projection Assumptions (used in the deterministic and stochastic asset/liability projections): These projections begin with the Plan's participant population as of December 31, 2014, as provided by the Hay Group. The Plan's population is projected forward and assumed to change as a result of employment separation, death, disability, and retirement, as predicted by the assumptions used in the December 31, 2014 actuarial valuation prepared by the Hay Group (and described on the prior pages). New members are assumed to enter the Plan such that the active population remains level throughout the projection. Employee compensation is projected into the future in accordance with the assumptions described on the prior pages. Investment returns are projected into the future in accordance with the assumptions described below.

Employer Contributions

For all fiscal years of the projection, employer contributions are assumed to equal the amount determined under the contribution policy, adjusted by Act 2010-120 contribution collars, if applicable.

Member Contributions

Member contributions are determined based on current contribution rates, and projected pay.

New Entrants

New employees are assumed to join the Plan such that the active population remains level throughout the projection. New employees entering the Plan are assumed to have characteristics similar to recently hired participants.

Appendix 3: Assumptions and Methods (continued)

Rate of Return on Assets

Deterministic Analysis: 7.50%, compounded annually.

Stochastic Analysis: Returns on the portfolio are based on the expected returns of each asset class and the correlations between each class which are detailed in the Stochastic Analysis section of this report.

Base Wages

Deterministic Analysis: 3.05% increases per year.

Stochastic Analysis: Increases that vary with inflation.

Inflation

2.50% per year with a standard deviation of 3.00%.

Other

All other projection assumptions are the same as those used in the December 31, 2014 actuarial valuation prepared by the Hay Group.

The participant data provided by the Hay Group was the same as that used in the actuarial valuation as of December 31, 2014. Active member records were grouped on age, category, class and pay for efficient data processing.

Correlation Matrix

Creating a diversified portfolio of asset classes enables the investor to achieve a high rate of return while minimizing volatility of the portfolio. Diversification exists because the returns of different asset classes do not always move in the same direction, at the same time, or with the same magnitude. Varied investment environments cause some asset classes to rise in value while others fall, and correlation is the measure that quantifies the degree to which asset classes do not move in tandem.

Correlation can take on values between 1.00 and -1.00. If returns of two asset classes rise or fall at the same time they are said to be perfectly correlated and have a correlation value of 1.00. Conversely, two asset classes that simultaneously move in opposite directions are said to be perfectly negatively correlated and have a correlation value of -1.00. A correlation of 0 indicates no relationship between the returns. It is imperfect correlations between asset classes that enable an investor to create efficient portfolios; that is, those with the highest amount of return at a given level of risk. The correlations for the asset classes used in this study are shown in Table 1 (next page).

The fact that the correlations shown in the table are nearly all positive does not imply that these asset classes do not diversify one another. Their correlations are significantly less than 1.00, meaning we expect a measurable number of instances when the underperformance of one or more of the asset classes will be offset by the outperformance of others.

	Global Equity	SERS Fixed Income	SERS Real Estate	SERS Multi-Strategy	Private Equity	Cash Equivalents
Global Equity	1.00	0.15	0.35	0.75	0.79	-0.03
SERS Fixed Income	0.15	1.00	-0.01	0.12	0.01	0.09
SERS Real Estate	0.35	-0.01	1.00	0.27	0.60	0.16
SERS Multi-Strategy	0.75	0.12	0.27	1.00	0.74	0.07
Private Equity	0.79	0.01	0.60	0.74	1.00	-0.22
Cash Equivalents	-0.03	0.09	0.16	0.07	-0.22	1.00

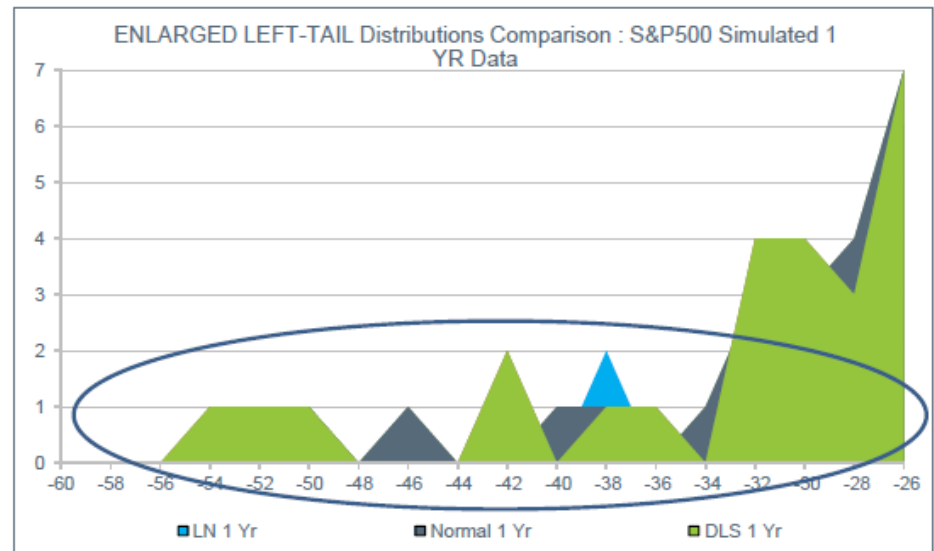
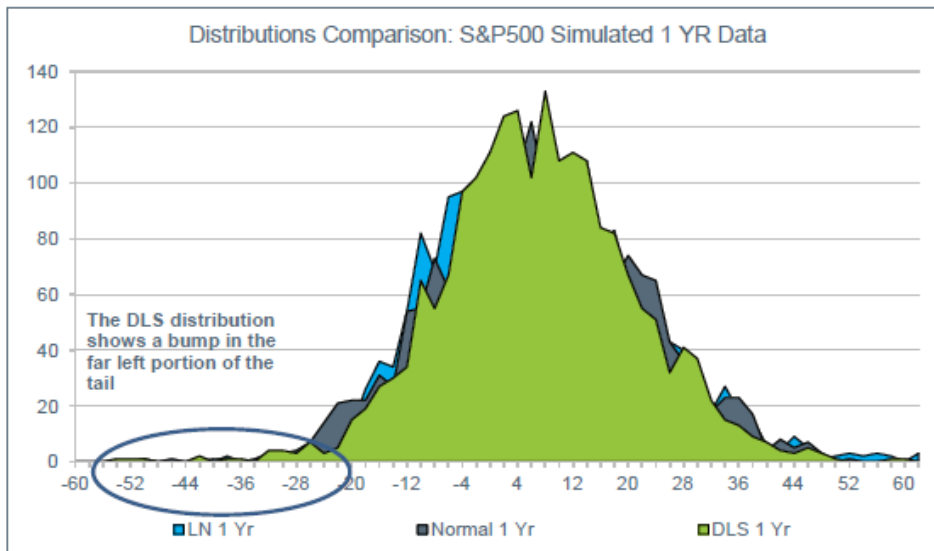
Monte Carlo Simulation

Monte Carlo simulation uses a random sampling of asset class returns, based on the probability distribution implied by the empirical returns, to create several thousand estimates of portfolio performance. Undergoing a Monte Carlo simulation provides insight into the performance of the asset allocation by examining many randomly sampled return outcomes.

An asset allocation study allows for the construction of an "efficient," or return-maximizing, portfolio of asset class investments at each given level of portfolio volatility. These calculations are based on expected return, risk, and correlations for each asset class. The asset allocation process provides a snapshot of portfolio performance that is highly dependent on the mean return expectations. A Monte Carlo simulation process "stress tests" these assumptions and asset allocation recommendations that stem from them through thousands of independent samplings of portfolio returns, based on the assumptions and indicated asset allocations. Through the Monte Carlo simulation process, we are better able to ascertain the real-world probability of achieving various return targets over time.

Our Monte Carlo simulation model assumes a non-normal (downside log-stable (DLS), or "fat-tailed") distribution of returns, which we believe provides a more realistic representation of historical market experience than the typically used normal or log-normal (LN) distribution. Given this non-normal distribution of random returns derived from our assumption inputs and empirical return dispersion, we can estimate the potential return for a given portfolio over the indicated time period. The charts below illustrate the differences between the above mentioned distributions.

It is important to note that the output that follows refers to geometric (compound) return, rather than the arithmetic return assumptions used in the asset allocation analysis. The geometric return of a portfolio will be less than (or equal to) its arithmetic return over time, because geometric return accounts for the dampening effect of volatility on the portfolio's compound returns.



Thematic and Liquidity Metrics

Asset Class	Thematic Bucket	Liquidity Bucket	RVK Liquidity Metric
Broad US Equity	Capital Appreciation	Liquid	95
Large/Mid Cap US Equity	Capital Appreciation	Liquid	95
Broad International Equity	Capital Appreciation	Liquid	90
Dev'd Large/Mid Cap Int'l Equity	Capital Appreciation	Liquid	90
Global Equity	Capital Appreciation	Liquid	90
Dev'd Small Cap Int'l Equity	Capital Appreciation	Liquid	85
Emerging Markets Equity	Capital Appreciation	Liquid	85
Small Cap US Equity	Capital Appreciation	Liquid	85
Convertibles	Capital Appreciation	Liquid	80
Distressed Debt	Capital Appreciation	Less Liquid	50
Emerging Markets Debt (Local and Hard)	Capital Appreciation	Less Liquid	50
High Yield Fixed Income	Capital Appreciation	Less Liquid	50
Non-Core Real Estate	Capital Appreciation	Not Liquid	5
Private Equity	Capital Appreciation	Not Liquid	5
T-Bills and Treasuries	Capital Preservation	Liquid	100
Cash Equivalents	Capital Preservation	Liquid	98
Int. Duration Fixed Income	Capital Preservation	Liquid	85
Long Duration Fixed Income	Capital Preservation	Liquid	85
Low Duration Fixed Income	Capital Preservation	Liquid	85
Stable Value	Capital Preservation	Less Liquid	50
Non-US Dev'd Sovereign Fixed Income UH	Capital Preservation	Less Liquid	50
GTAA	Alpha	Liquid	88
Diversified Hedge Funds	Alpha	Less Liquid	35
Equity Market Neutral	Alpha	Less Liquid	35
Long-Biased Long/Short Equity	Alpha	Less Liquid	35
Managed Futures FoF	Alpha	Less Liquid	35
Commodities	Inflation	Liquid	98
TIPS	Inflation	Liquid	95
Diversified Inflation Strategies	Inflation	Liquid	93
Global REITs/MLPs	Inflation	Liquid	85
Bank Loans	Inflation	Less Liquid	50
Core Real Estate	Inflation	Not Liquid	25
Infrastructure	Inflation	Not Liquid	5
Timber	Inflation	Not Liquid	5

PORTLAND

CHICAGO

NEW YORK

