



Asset-Liability Study Results

Nebraska Public Employees Retirement System (NPERS)
July 2021

Investment advice and consulting services provided by Aon Investments USA Inc.

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Comprehensive Overview

Asset-Liability Management Overview

What?

- A comprehensive toolkit for making decisions on a fund's asset allocation and investment risk that align with the liabilities those funds support

Why?

- Aon believes optimal decisions regarding pension plan management are made when they are based on a clear understanding of the assets and liabilities of the plan(s) and how they interact

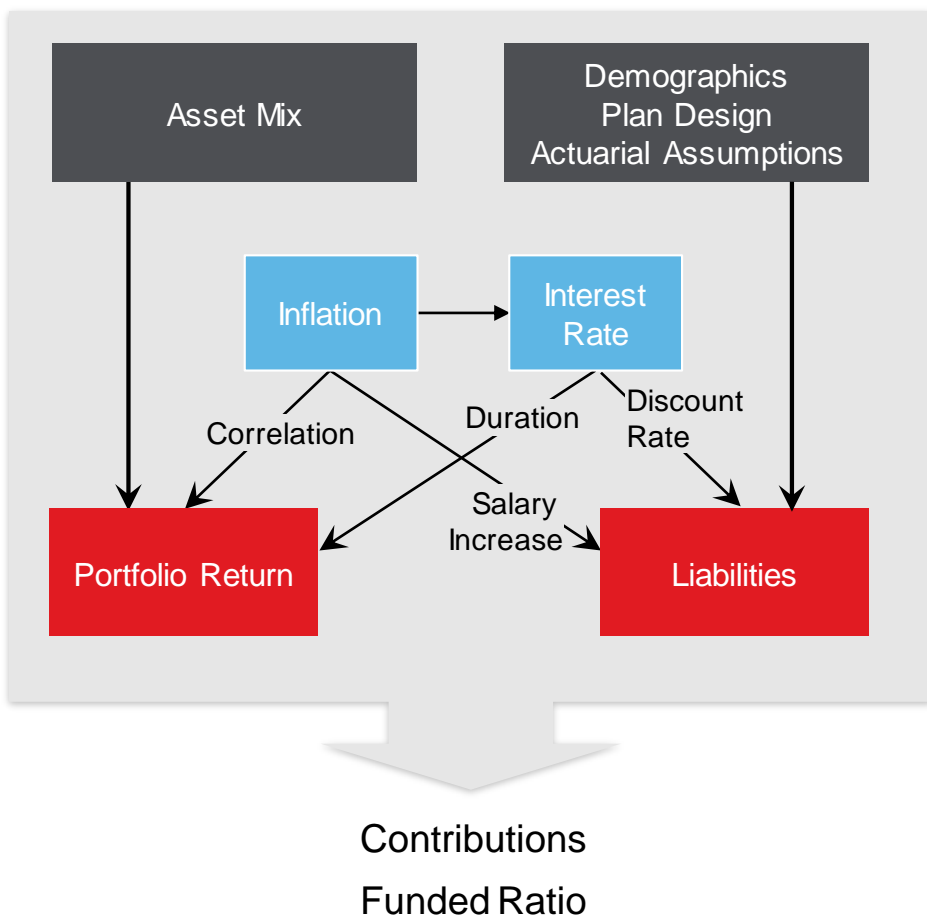
When?

- For a formal review of the asset-liability modeling, Aon suggests conducting asset-liability studies every three to five years depending on client specifics, or more frequently should circumstances dictate (e.g., material changes to the liability profile, etc.)

How?

- Identify future trends in the financial health of the fund (e.g., funded ratio, contributions, etc.) based on economic uncertainties that may not be evident from an actuarial valuation, which provides only a snapshot at a point in time

Mechanics of Asset-Liability Modeling Process



Asset and liability modeling integrated in single platform

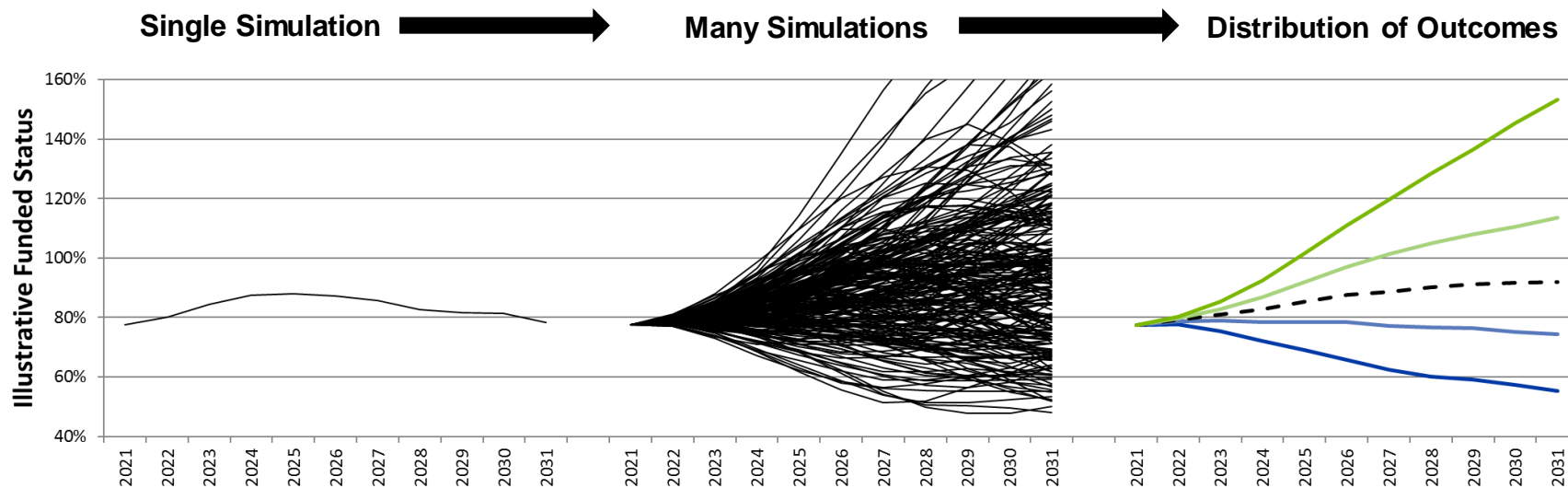
- Integrates impact of key economic variables

Flexibility in modeling parameters and output to client preferences

Stochastic and deterministic modeling performed

Asset-Liability Simulation Overview

- Thousands of simulations plotted in one graph would be impossible to interpret
- Instead, we rank the simulations at each point over the future
- This produces a distribution of outcomes illustrating the degree of uncertainty of a plan's financial position over the projection period
- Different investment strategies will produce different distributions of outcomes



* The path of a given scenario will follow a much less smooth pattern than the distribution suggests, as illustrated above

Current State Asset-Liability Profile

	School	State Patrol	Judges	State Cash Balance	County Cash Balance
Valuation Date	7/1/2020			1/1/2021	
Market Value of Assets (in \$millions)	\$12,273.8	\$435.8	\$194.5	\$1,991.7	\$655.4
Actuarial Liability (in \$millions)	\$13,832.5	\$510.8	\$206.5	\$1,795.4	\$599.4
Funded Ratio	88.7%	85.3%	94.2%	110.9%	109.3%
Liability Growth Rate					
- Normal Cost	1.91%	1.67%	2.58%	3.77%	4.64%
- Discount Cost	7.50%	7.50%	7.50%	7.30%	7.30%
- Total	9.41%	9.17%	10.08%	11.07%	11.94%
Asset Hurdle Rate ¹	10.61%	10.75%	10.70%	9.98%	10.92%
Expected Return on Assets ²	6.31%	6.31%	6.31%	6.31%	6.31%

Key Takeaways:

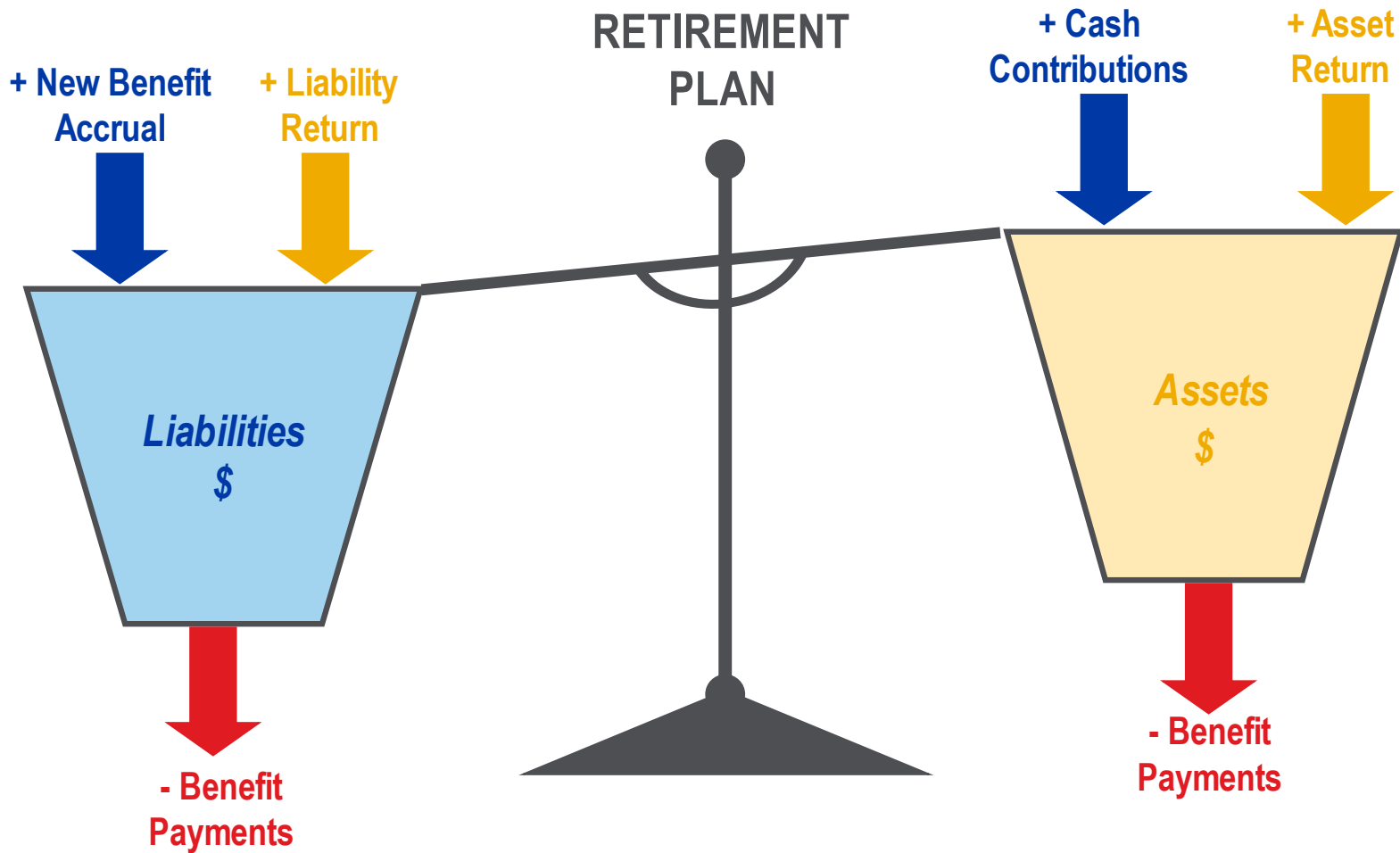
- Plans are well-funded with the School Plan representing 80% of the total (assets and liabilities)
- Similar asset hurdle rates, or asset growth needs, has led to similar asset allocations across plans
- From these starting points, the analysis layers on actual YTD returns (+22.33% for traditional plans; +4.14% for cash balance plans)

¹ The rate of growth needed by the assets (through both contributions and investment returns) to keep pace with the growth of the liability.

² Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

³ Totals and percentages may not sum as shown due to rounding.

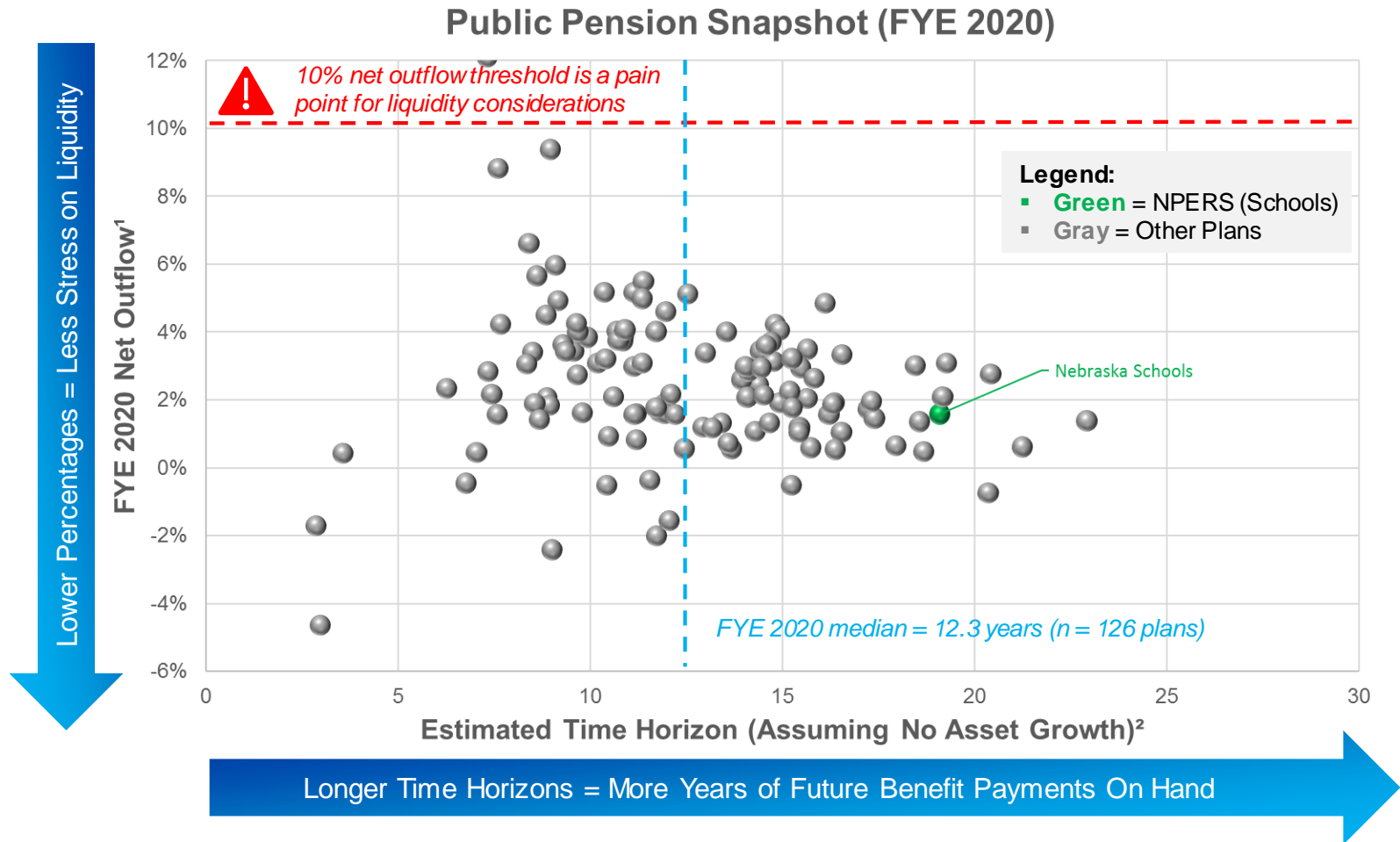
Balance of Liabilities and Assets



Plan Funding

- Investment strategy, and the desired levels of asset returns needed, should consider Plan funding
- NPERS has a two-tier contribution policy for the School, State Cash Balance, and County Cash Balance Plans
 - Contributions are the greater of (1) the actuarially-determined amount or (2) statutory, payroll-based amounts
 - These plans currently contribute more than the actuarial amount, focusing more on plan funding than investment returns which could potentially lessen the need for asset returns over the long-term
- The State Patrol and Judges Plans are currently being funded on the actuarially-determined contribution amount and have more need for higher level of return-seeking assets to fund them

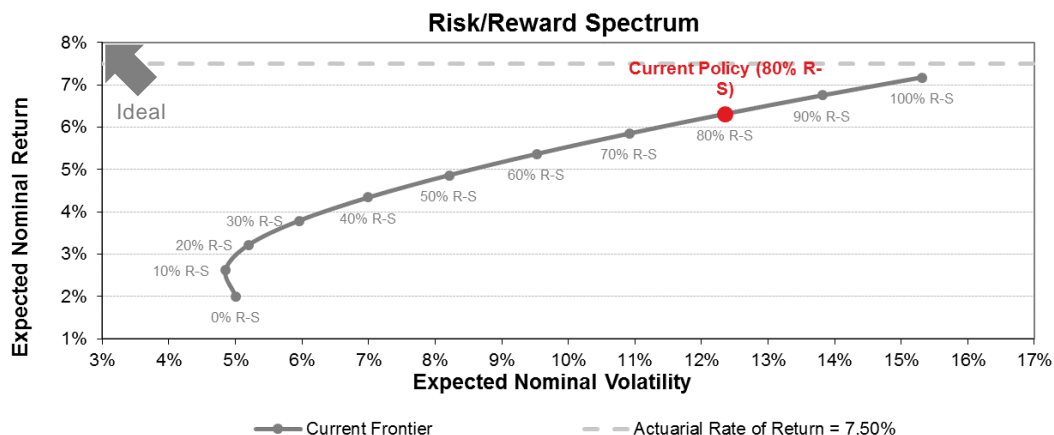
Public Pension Snapshot (Fiscal Year Ending 2020)



¹ Net Outflow calculated as (Benefit Payments – Total Contributions) / Market Value of Assets

² Estimated Time Horizon = FYE 2020 Market Value of Assets / FYE 2020 Benefit Payments

Portfolio Analysis | Risk/Reward Spectrum



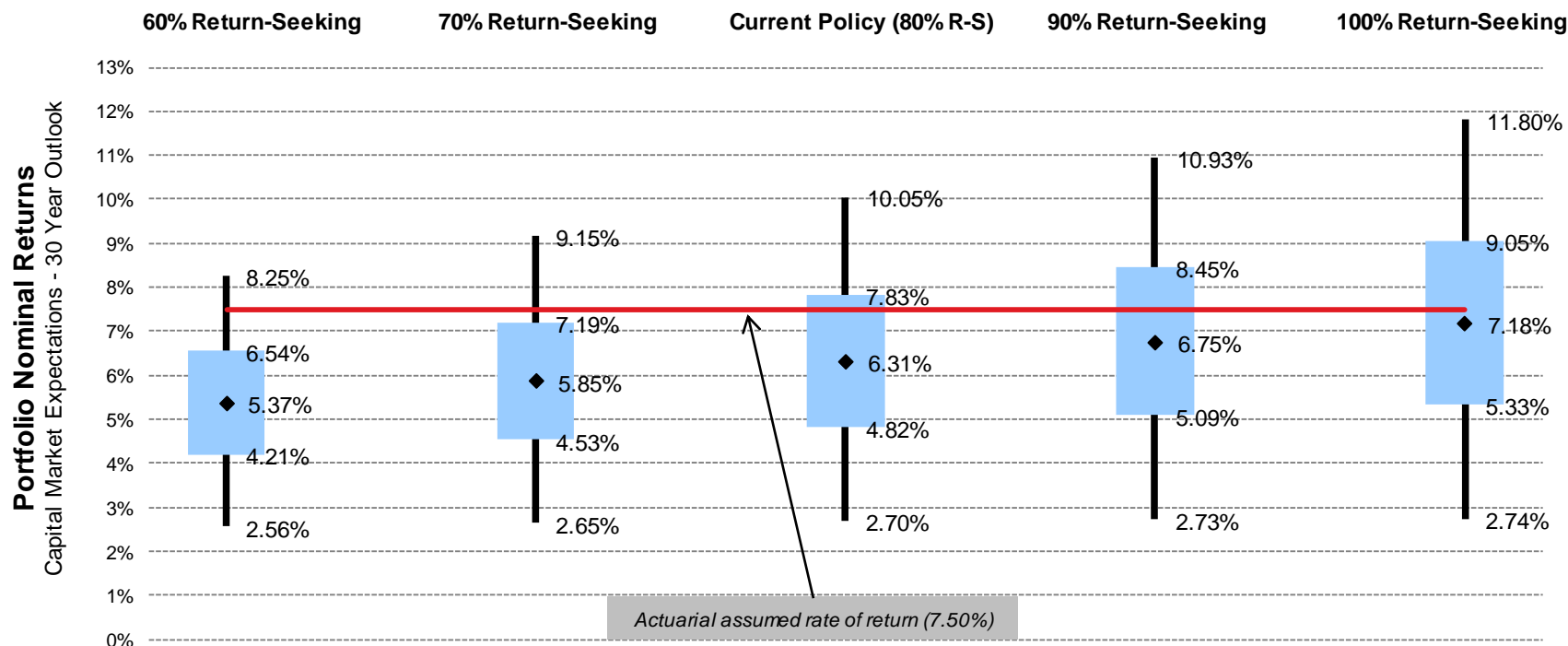
Key Takeaways:

- Current portfolio has an expected return of **6.31%**, which falls short of the actuarial assumed rate of return (7.50%)
- Return-Seeking* assets are diversified with public equity, private equity, real estate, and non-core fixed income
- Risk-Reducing / Safety* assets are comprised of core fixed income

				Return-Seeking Assets				Risk-Reducing / Safety Assets
	Expected Nominal Return	Expected Nominal Volatility	Sharpe Ratio	Public Equity	Private Equity	Non-Core Bonds	Real Estate	Core Bonds
Current Policy (80% R-S)	6.31%	12.35%	0.422	57.5%	5.0%	10.0%	7.5%	20.0%
Current Frontier								
0% Return-Seeking	2.00%	5.00%	0.180	0.0%	0.0%	0.0%	0.0%	100.0%
10% Return-Seeking	2.62%	4.85%	0.314	7.2%	0.6%	1.3%	0.9%	90.0%
20% Return-Seeking	3.22%	5.20%	0.407	14.4%	1.3%	2.5%	1.9%	80.0%
30% Return-Seeking	3.79%	5.96%	0.451	21.6%	1.9%	3.8%	2.8%	70.0%
40% Return-Seeking	4.34%	6.99%	0.463	28.8%	2.5%	5.0%	3.8%	60.0%
50% Return-Seeking	4.86%	8.21%	0.459	35.9%	3.1%	6.3%	4.7%	50.0%
60% Return-Seeking	5.37%	9.53%	0.448	43.1%	3.8%	7.5%	5.6%	40.0%
70% Return-Seeking	5.85%	10.92%	0.435	50.3%	4.4%	8.8%	6.6%	30.0%
80% Return-Seeking	6.31%	12.35%	0.422	57.5%	5.0%	10.0%	7.5%	20.0%
90% Return-Seeking	6.75%	13.82%	0.409	64.7%	5.6%	11.3%	8.4%	10.0%
100% Return-Seeking	7.18%	15.31%	0.397	71.9%	6.3%	12.5%	9.4%	0.0%

Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix. Percentages may not sum to 100% due to rounding.

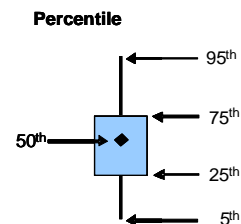
Portfolio Analysis | Range of Nominal Returns



Key Takeaways:

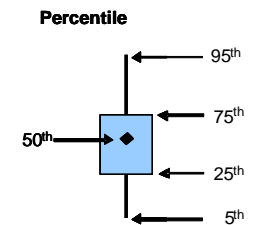
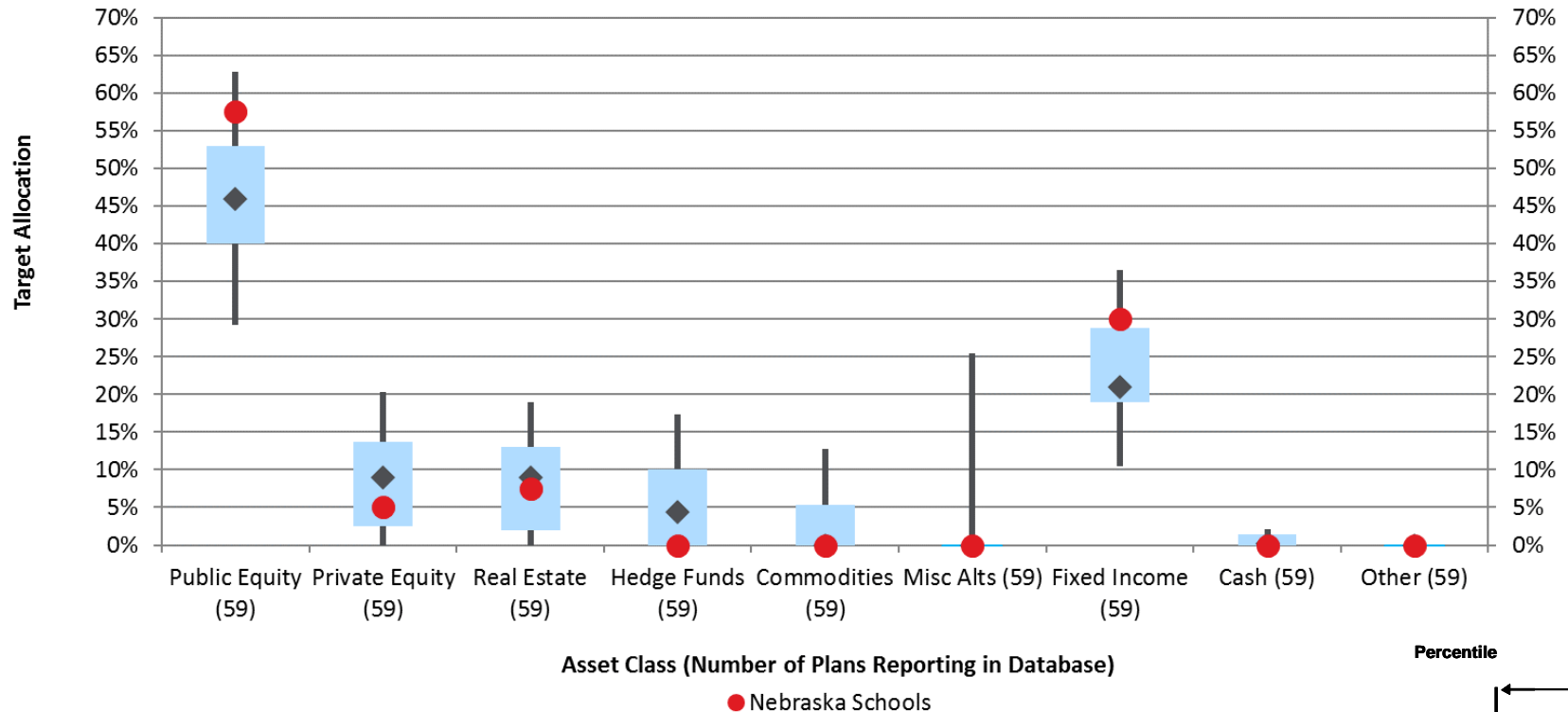
- Each strategy will have a range of potential outcomes around the median expectation
- Higher allocation to return-seeking assets will increase the median return but also the volatility of returns

Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are medians and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.



Distribution of U.S. Public Pension Target Asset Allocations Assets > \$10B¹

Distribution of U.S. Public Pension Target Asset Allocations (FYE 2020)

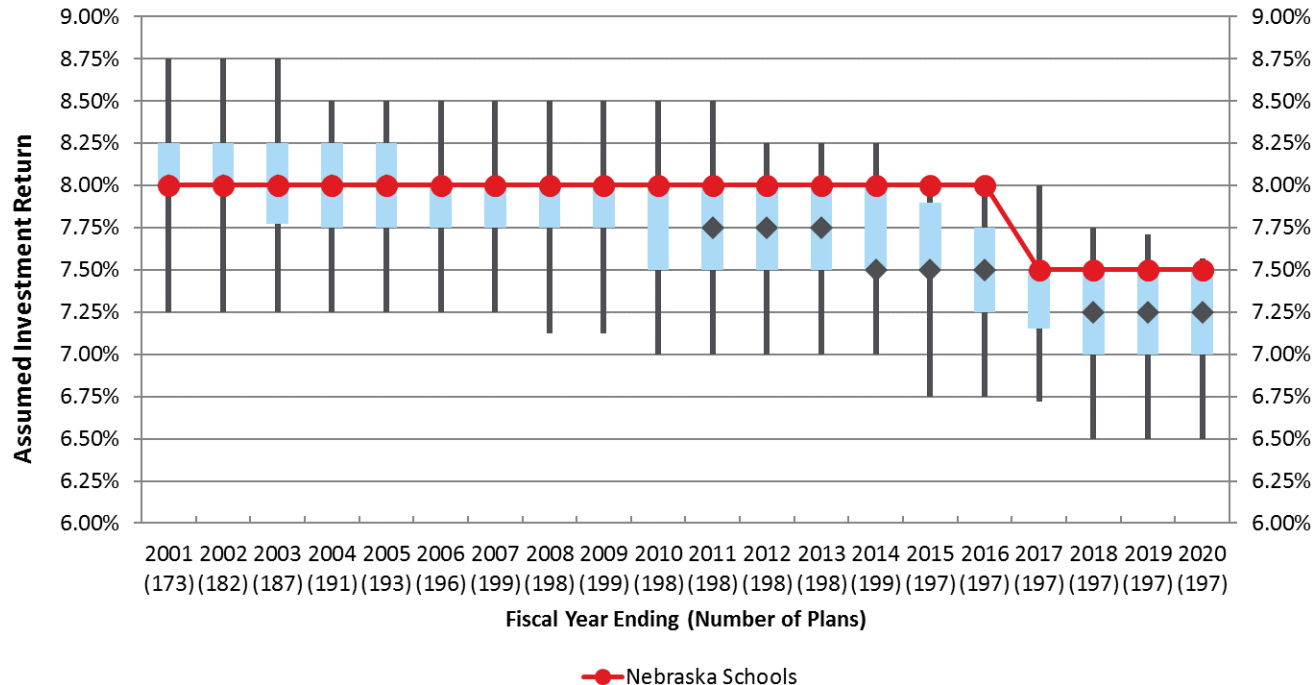


Sources: Public Plans Data (publicplansdata.org) as of April 2021;

¹ Peers defined as public funds published within publicplansdata.org as of April 2021; Number of plans per year are shown in parentheses

Expected Return Assumption versus Peers¹

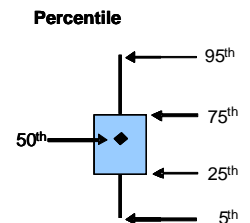
Distribution of U.S. Public Pension Investment Return Assumptions



Key Takeaways:

- The public pension peer median actuarial assumption for investment return has declined from 8.00% in 2001-2010 to 7.25% based on the latest survey data
- The Schools' assumption for FYE 2020 (7.50%) lied above the median relative to its peers
- If the Schools exceeds (or falls short of) the actuarial return assumption, lower (or higher) funding will be needed in future years

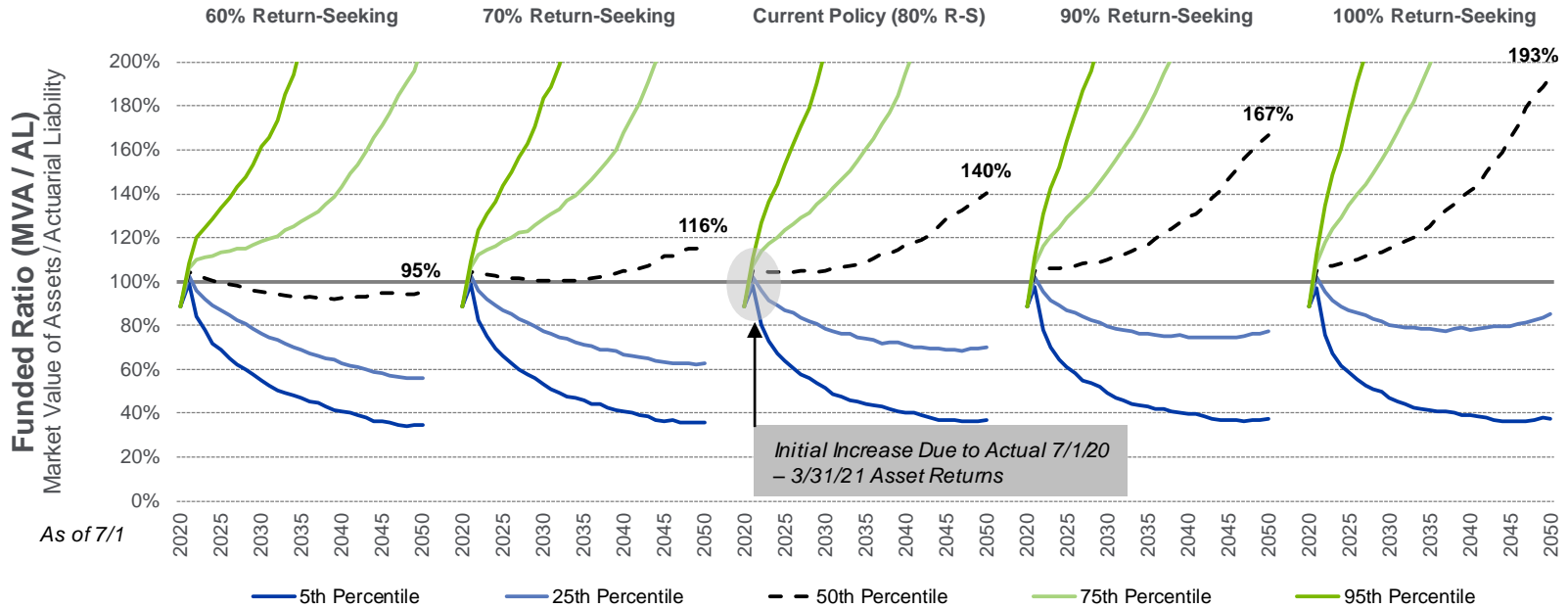
Note: All pension plans will be reducing their expected return assumptions in future years: 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+)



Sources: Public Plans Data (publicplansdata.org) as of April 2021; Expected Returns are the assumptions made by the plans included in the data set.
¹ Peers defined as public funds published within publicplansdata.org as of April 2021; Number of plans per year are shown in parentheses

School Retirement System

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	55%	41%	35%	53%	41%	36%	51%	40%	37%	49%	40%	37%	47%	39%	38%
25th Percentile	76%	63%	56%	78%	67%	62%	79%	71%	70%	79%	74%	77%	80%	78%	85%
50th Percentile	95%	93%	95%	100%	105%	116%	105%	117%	140%	110%	129%	167%	115%	141%	193%
75th Percentile	118%	143%	>200%	128%	168%	>200%	139%	195%	>200%	150%	>200%	>200%	161%	>200%	>200%
95th Percentile	162%	>200%	>200%	183%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%

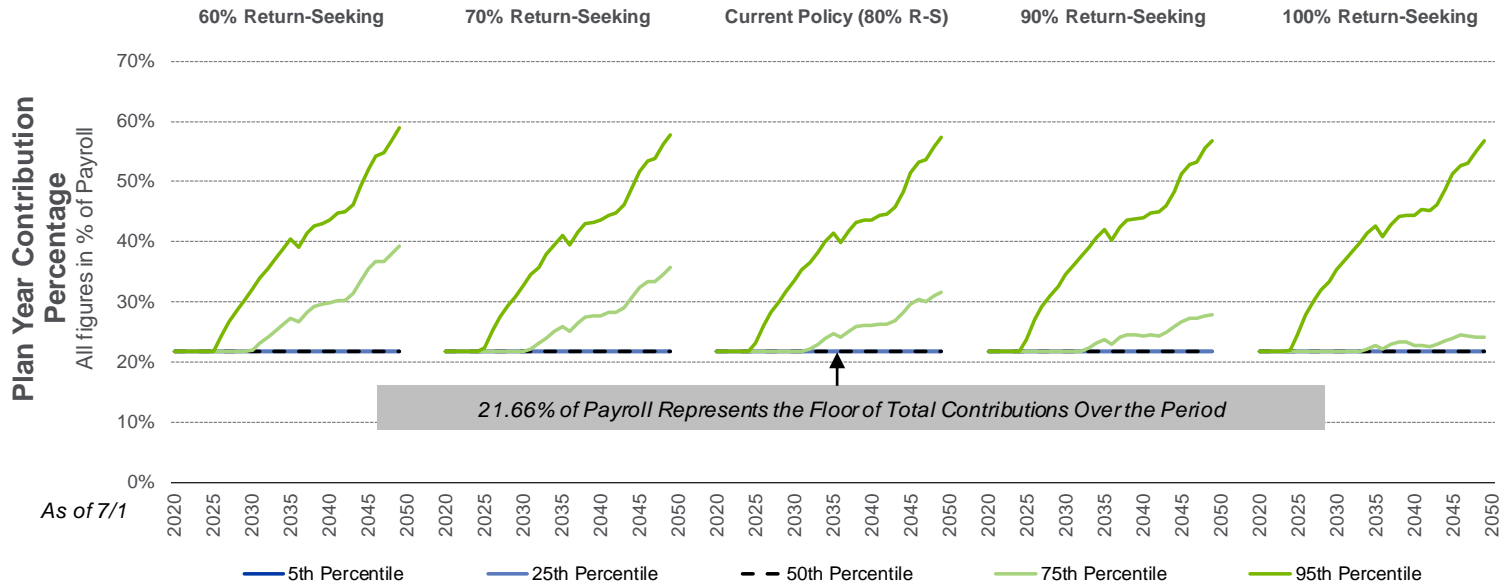
Key Takeaways:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 70% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

School Retirement System

Total Contribution Percentage of Payroll



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
25th Percentile	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
50th Percentile	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%	22%
75th Percentile	22%	30%	39%	22%	28%	36%	22%	26%	32%	22%	25%	28%	22%	23%	24%
95th Percentile	30%	43%	59%	31%	43%	58%	32%	44%	57%	32%	44%	57%	33%	44%	57%

Key Takeaways:

- Total contribution percentages (Employee + Employer + State) are not expected to be above the statutory amount (21.66%) in our central expectation (50th percentile outcomes) across investment strategies
- Statutory amounts being greater than the actuarially-determined amount is advancing funding into the Plan

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

School Retirement System

Summary and Conclusions

All Scenarios \$ Billions	30-year Economic Cost		30-year Present Value of Contributions		30-year Ending Funded Ratio (MVA / AL)	
	Expected ¹	Downside ²	Expected ¹	Downside ²	Expected ¹	Downside ³
Current Policy (80% R-S)	\$6.4	\$12.3	\$7.9	\$11.1	140%	37%
Current Frontier of Results						
0% Return-Seeking	\$12.1	\$13.7	\$9.8	\$10.7	37%	23%
10% Return-Seeking	\$11.5	\$13.2	\$9.4	\$10.6	41%	25%
20% Return-Seeking	\$10.8	\$12.9	\$9.0	\$10.5	47%	28%
30% Return-Seeking	\$10.1	\$12.6	\$8.7	\$10.5	54%	29%
40% Return-Seeking	\$9.4	\$12.5	\$8.4	\$10.6	64%	31%
50% Return-Seeking	\$8.7	\$12.4	\$8.2	\$10.7	77%	33%
60% Return-Seeking	\$7.9	\$12.3	\$8.1	\$10.8	95%	35%
70% Return-Seeking	\$7.1	\$12.3	\$8.0	\$10.9	116%	36%
80% Return-Seeking	\$6.4	\$12.3	\$7.9	\$11.1	140%	37%
90% Return-Seeking	\$5.9	\$12.3	\$7.9	\$11.2	167%	37%
100% Return-Seeking	\$5.4	\$12.4	\$7.9	\$11.3	193%	38%

Key Findings:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 70% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

¹ Expected = 50th percentile outcome or central expectation across all 5,000 simulations

² Downside = 95th percentile outcome across all 5,000 simulations

³ Downside = 5th percentile outcome across all 5,000 simulations

Summary of Results

All Plans

Investment Strategy	School		State Patrol		Judges	
	30-year Ending Funded Ratio (MVA/ AL)		30-year Ending Funded Ratio (MVA/ AL)		30-year Ending Funded Ratio (MVA/ AL)	
	Expected ¹	Downside ²	Expected ¹	Downside ²	Expected ¹	Downside ²
60% Return-Seeking Assets	95%	35%	81%	40%	78%	37%
70% Return-Seeking Assets	116%	36%	92%	41%	89%	38%
80% Return-Seeking Assets	140%	37%	107%	42%	103%	39%
Investment Strategy	State Cash Balance		County Cash Balance			
	30-year Ending Funded Ratio (MVA/ AL)		30-year Ending Funded Ratio (MVA/ AL)			
	Expected ¹	Downside ²	Expected ¹	Downside ²		
60% Return-Seeking Assets	99%	50%	96%	51%		
70% Return-Seeking Assets	116%	51%	110%	52%		
80% Return-Seeking Assets	136%	52%	128%	53%		

Key Findings:

- The return-seeking level needed to achieve full funding over the projection period differs by plan

¹ Expected = 50th percentile outcome or central expectation across all 5,000 simulations

² Downside = 5th percentile outcome across all 5,000 simulations

Summary & Conclusions



- Asset returns through March 31, 2021 boosted initial funded ratios
- Funded ratio projections move largely sideways over the first 10-15 years before trending higher
- For the School, State Cash Balance, and County Cash Balance Plans, contributions are more than the actuarially-determined amounts, resulting in higher funded ratios over the period



- Three facets of investment strategy
 - **Asset Allocation:** 70% and 80% return-seeking strategies appear reasonable given the sideways movement of funded ratio projections over the first 10-15 years
 - **Return-Seeking Portfolio:** continue utilizing the existing asset classes of public equity, private equity, real estate, and non-core fixed income
 - **Safety / Risk-Reducing Portfolio:** continue utilizing core fixed income allocation



- Funding should be considered when determining the investment strategy
 - Contributions over and above the actuarial amount may ultimately lessen the reliance on investment returns to grow the assets



Additional Analysis

- School Retirement System

School Retirement System

Current State Asset-Liability Profile As of July 1, 2020

Asset-Liability Snapshot as of 7/1/2020		
Metric (\$, Millions)	Value	Fund %
Market Value of Assets	\$12,273.8	88.7%
Actuarial Value of Assets	\$12,680.2	91.7%
Liability Metrics		
Actuarial Liability (AL) - Funding	\$13,832.5 ¹	

Asset-Liability Growth Metrics			
Metric (\$, Millions)	Value	% Liability	% Assets
AL Discount Cost	\$1,037.4	7.50%	8.45%
AL Normal Cost	\$264.8	1.91%	2.16%
Total Liability Hurdle Rate	\$1,302.2	9.41%	10.61%
Expected Return on Assets ²	\$774.8	5.60%	6.31%
Total Contributions	\$466.0	3.37%	3.80%
Total Exp. Asset Growth	\$1,240.8	8.97%	10.11%
Hurdle Rate Shortfall/(Surplus)	\$61.4	0.44%	0.50%
Est. Benefit Payments	\$767.6	5.55%	6.25%

¹ Based on a 7.50% discount rate consistent with the July 1, 2020 valuation results.

² Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions.

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Key Takeaways:

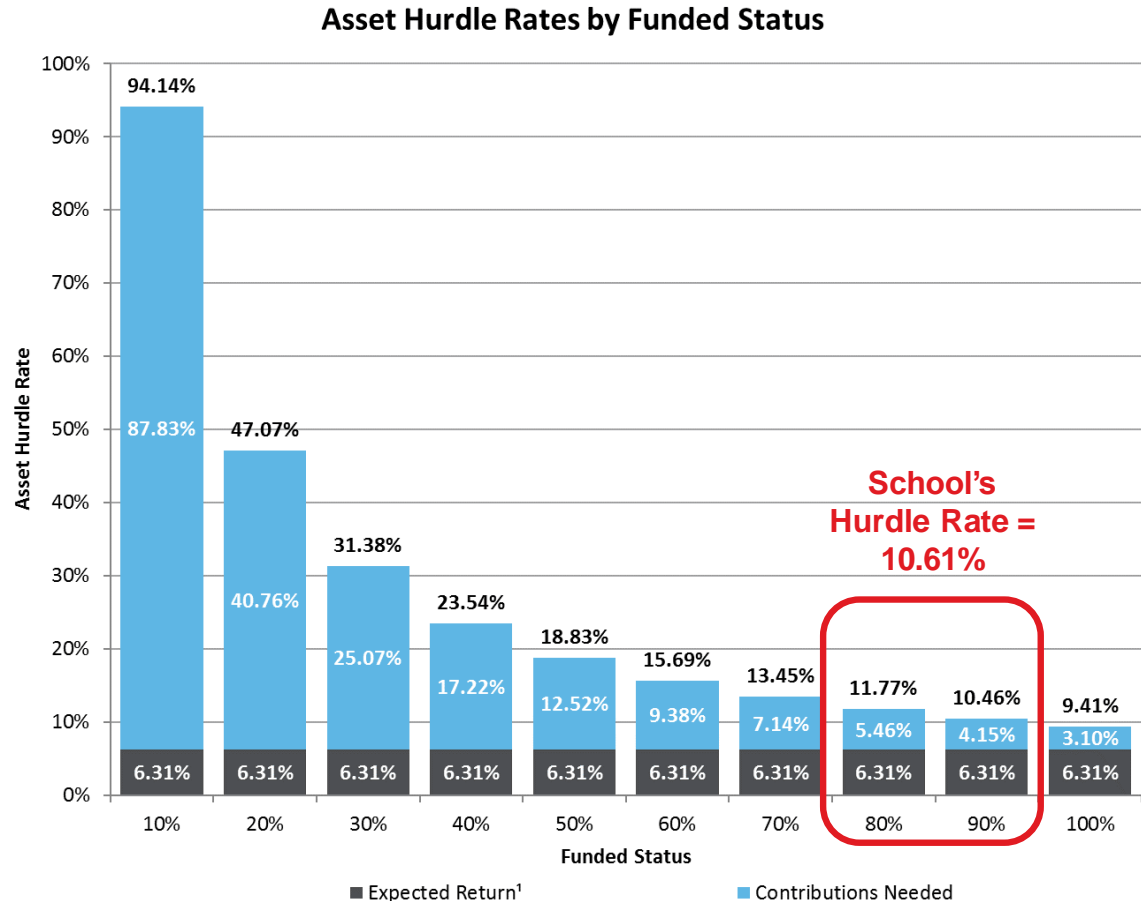
- Pension plan is 88.7% funded on a market value of assets basis as of July 1, 2020
- Asset allocation is 80% return-seeking assets with 20% risk-reducing/safety assets to withstand stressed markets
- Asset hurdle rate of 10.61%, via cash funding and investment returns, needed to maintain or improve actuarial funded status

Target Asset Allocation as of 7/1/2020		
Metric (\$, Millions)	Value	Alloc %
Return-Seeking		
- U.S. Equity	\$3,313.9	27%
- International Equity	\$1,411.5	12%
- Global Equity	\$2,332.0	19%
- Private Equity	\$613.7	5%
- Real Estate	\$920.5	8%
- Non-Core Bonds	\$1,227.4	10%
- Total	\$9,819.0	80%
Risk-Reducing		
- Core Bonds	\$2,454.8	20%
- Total	\$2,454.8	20%
Total	\$12,273.8	100%

School Retirement System

Asset Hurdle Rate

- **Asset Hurdle Rate** is the level of asset growth needed to keep pace with the growth of the Plan liabilities
 - Assets must grow at this rate or more in order to maintain or reduce the existing funding shortfall
- Assets can grow via:
 - Investment performance, and/or
 - Funding contributions
- Asset hurdle rates increase as funded ratio declines, as shown in the chart to the right



Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

School Retirement System

Funded Ratio Analysis (Based on Market Value of Assets)

The **School Retirement System** is projected to have the following probability of exceeding key funded ratio thresholds under the Current portfolio mix:

Funded Status	After 5 Years					After 10 Years					After 30 Years				
	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S
100%	48.8%	53.0%	56.4%	58.9%	60.7%	44.1%	50.1%	54.7%	58.2%	60.5%	48.1%	55.1%	61.3%	66.0%	69.9%
90%	68.5%	69.7%	70.8%	71.5%	71.8%	57.0%	61.8%	64.9%	67.1%	68.3%	52.1%	59.3%	65.0%	69.9%	73.1%
80%	85.0%	84.1%	83.3%	82.3%	81.5%	70.3%	72.5%	73.9%	74.7%	75.1%	57.1%	64.1%	69.6%	73.9%	76.6%
70%	94.2%	93.0%	91.6%	90.4%	89.3%	82.2%	82.7%	82.8%	82.5%	82.4%	63.0%	69.6%	74.9%	78.1%	80.8%
60%	98.5%	97.6%	96.7%	95.6%	94.6%	91.9%	91.3%	90.4%	89.5%	88.7%	71.0%	76.9%	81.0%	83.6%	85.4%
50%	99.8%	99.4%	99.0%	98.4%	97.7%	97.2%	96.4%	95.6%	94.6%	93.8%	80.5%	84.6%	87.2%	88.7%	89.6%
40%	100.0%	100.0%	99.9%	99.6%	99.4%	99.7%	99.1%	98.8%	98.2%	97.4%	90.4%	92.1%	93.2%	93.7%	94.2%
30%	100.0%	100.0%	100.0%	100.0%	99.9%	100.0%	99.9%	99.8%	99.7%	99.3%	97.5%	97.7%	98.0%	97.9%	97.8%
20%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%	99.9%	99.8%	99.8%	99.7%
10%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

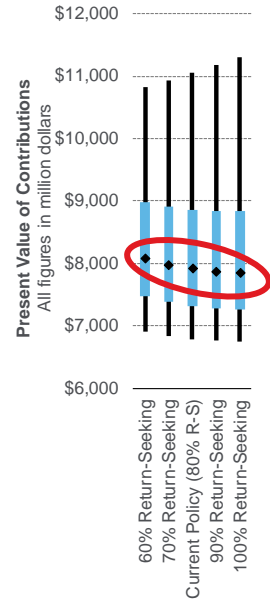
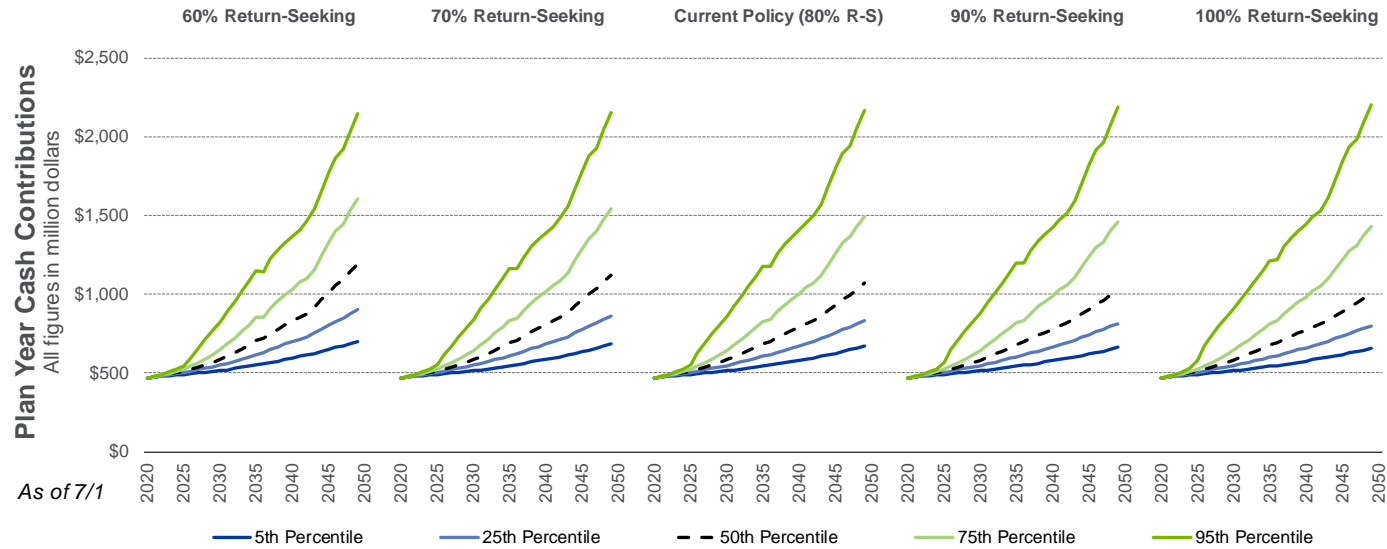
Key Takeaway:

- Higher risk portfolios are projected to have more upside potential over longer periods of time while lower risk portfolios are expected to have higher downside protection in the near-term

Blue = Greater than 50% chance of surpassing a given threshold

School Retirement System

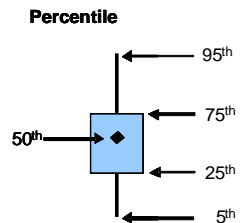
Total Contribution Amount



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	\$511	\$584	\$700	\$510	\$578	\$682	\$510	\$572	\$670	\$510	\$570	\$662	\$510	\$568	\$655
25th Percentile	\$540	\$682	\$906	\$540	\$668	\$864	\$539	\$658	\$833	\$539	\$652	\$813	\$539	\$648	\$799
50th Percentile	\$569	\$804	\$1,192	\$568	\$783	\$1,121	\$568	\$769	\$1,072	\$567	\$758	\$1,032	\$567	\$753	\$1,005
75th Percentile	\$615	\$995	\$1,606	\$614	\$979	\$1,545	\$614	\$966	\$1,496	\$614	\$955	\$1,458	\$615	\$953	\$1,432
95th Percentile	\$768	\$1,323	\$2,151	\$785	\$1,343	\$2,156	\$805	\$1,362	\$2,168	\$827	\$1,382	\$2,190	\$852	\$1,405	\$2,207

Key Takeaways:

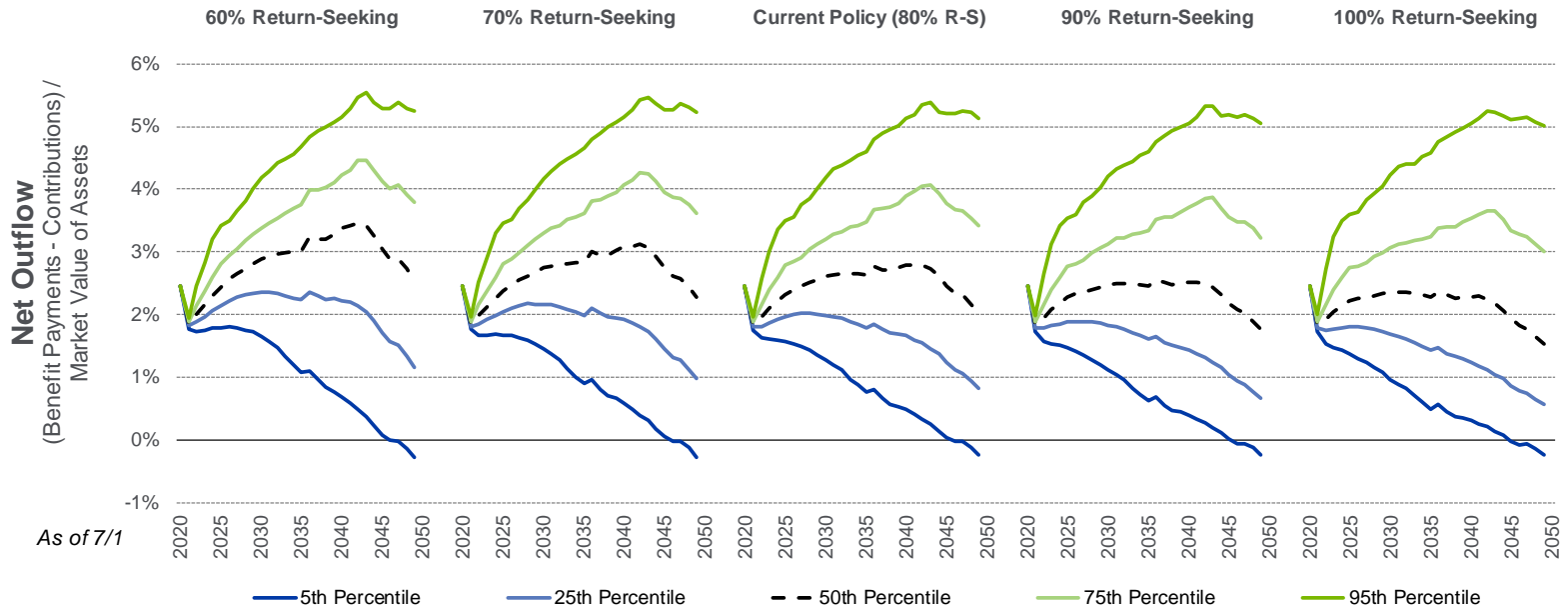
- Contribution amounts are projected to increase over the period with a floor of statutory, payroll-based contributions
- Increases to the return-seeking allocation will lower expected contribution rates (50th percentile outcomes) while increasing the volatility of those amounts



* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

School Retirement System

Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	1.7%	0.8%	-0.3%	1.5%	0.7%	-0.3%	1.4%	0.5%	-0.2%	1.2%	0.4%	-0.2%	1.1%	0.3%	-0.2%
25th Percentile	2.3%	2.3%	1.2%	2.2%	1.9%	1.0%	2.0%	1.7%	0.8%	1.9%	1.5%	0.7%	1.7%	1.3%	0.6%
50th Percentile	2.8%	3.3%	2.5%	2.7%	3.0%	2.3%	2.6%	2.8%	2.0%	2.4%	2.5%	1.8%	2.3%	2.3%	1.5%
75th Percentile	3.3%	4.1%	3.8%	3.2%	3.9%	3.6%	3.1%	3.8%	3.4%	3.1%	3.6%	3.2%	3.0%	3.5%	3.0%
95th Percentile	4.0%	5.1%	5.3%	4.0%	5.1%	5.2%	4.0%	5.0%	5.1%	4.0%	5.0%	5.1%	4.0%	5.0%	5.0%
Probability > 10%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Key Takeaway:

- Net outflow is consistent across the policies modeled with central expectations (50th percentile outcome) in the 1-4% range

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

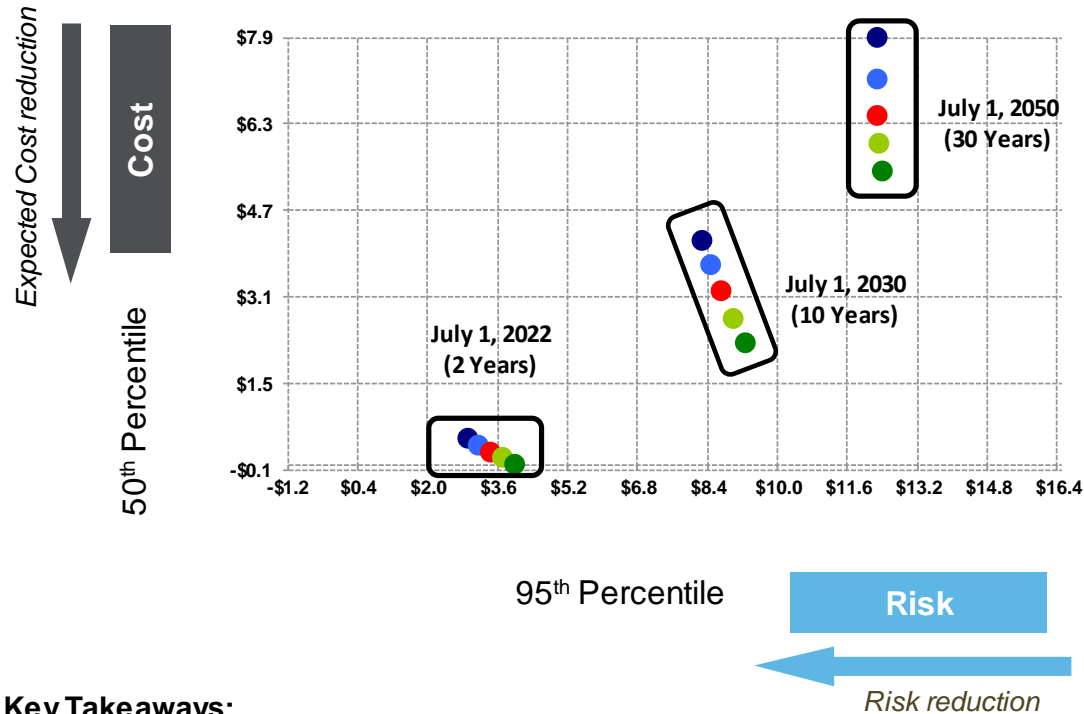
Proprietary & Confidential
Investment advice and consulting services provided by Aon Investments USA Inc.

School Retirement System

Economic Cost Analysis—2-Year, 10-Year, and 30-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 7.00%, \$billions



Economic Cost		
July 1, 2022		
Strategy (\$Billions)	Cost	Risk
60% Return-Seeking	\$0.5	\$3.0
70% Return-Seeking	\$0.3	\$3.2
Current Policy (80% R-S)	\$0.2	\$3.4
90% Return-Seeking	\$0.1	\$3.7
100% Return-Seeking	(\$0.0)	\$4.0
July 1, 2030		
Strategy (\$Billions)	Cost	Risk
60% Return-Seeking	\$4.1	\$8.3
70% Return-Seeking	\$3.7	\$8.5
Current Policy (80% R-S)	\$3.2	\$8.7
90% Return-Seeking	\$2.7	\$9.0
100% Return-Seeking	\$2.2	\$9.3
July 1, 2050		
Strategy (\$Billions)	Cost	Risk
60% Return-Seeking	\$7.9	\$12.3
70% Return-Seeking	\$7.1	\$12.3
Current Policy (80% R-S)	\$6.4	\$12.3
90% Return-Seeking	\$5.9	\$12.3
100% Return-Seeking	\$5.4	\$12.4

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- Under the Current Policy over a 30-year time horizon, the expected Economic Cost is \$6.4B and the potential risk is \$12.3B

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied; Reflects a *utility function*: Excludes 50% of surplus in excess of 120% of Actuarial liability, and includes twice the shortfall below 30% of Actuarial liability, on a market value basis



Additional Analysis

- State Patrol Retirement System

State Patrol Retirement System

Current State Asset-Liability Profile As of July 1, 2020

Asset-Liability Snapshot as of 7/1/2020		
Metric (\$, Millions)	Value	Fund %
Market Value of Assets	\$435.8	85.3%
Actuarial Value of Assets	\$450.2	88.1%
Liability Metrics		
Actuarial Liability (AL) - Funding	\$510.8 ¹	

Asset-Liability Growth Metrics			
Metric (\$, Millions)	Value	% Liability	% Assets
AL Discount Cost	\$38.3	7.50%	8.79%
AL Normal Cost	\$8.5	1.67%	1.96%
Total Liability Hurdle Rate	\$46.8	9.17%	10.75%
Expected Return on Assets ²	\$27.5	5.39%	6.31%
Total Contributions	\$14.3	2.79%	3.27%
Total Exp. Asset Growth	\$41.8	8.18%	9.58%
Hurdle Rate Shortfall/(Surplus)	\$5.1	0.99%	1.17%
Est. Benefit Payments	\$26.9	5.28%	6.18%

¹ Based on a 7.50% discount rate consistent with the July 1, 2020 valuation results.

² Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions.

Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

Percentages may not sum to 100% due to rounding.

Key Takeaways:

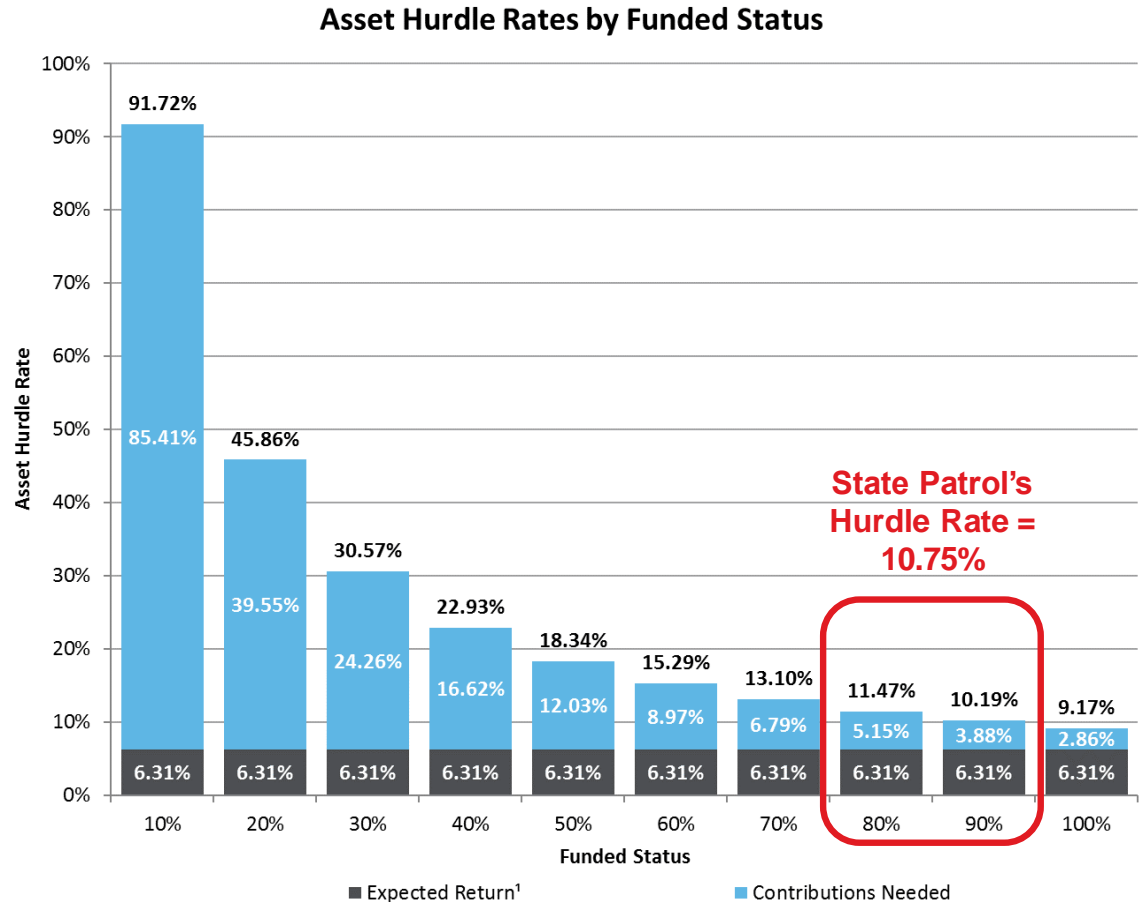
- Pension plan is 85.3% funded on a market value of assets basis as of July 1, 2020
- Asset allocation is 80% return-seeking assets with 20% risk-reducing/safety assets to withstand stressed markets
- Asset hurdle rate of 10.75%, via cash funding and investment returns, needed to maintain or improve actuarial funded status

Target Asset Allocation as of 7/1/2020		
Metric (\$, Millions)	Value	Alloc %
Return-Seeking		
- U.S. Equity	\$117.7	27%
- International Equity	\$50.1	12%
- Global Equity	\$82.8	19%
- Private Equity	\$21.8	5%
- Real Estate	\$32.7	8%
- Non-Core Bonds	\$43.6	10%
- Total	\$348.6	80%
Risk-Reducing		
- Core Bonds	\$87.2	20%
- Total	\$87.2	20%
Total	\$435.8	100%

State Patrol Retirement System

Asset Hurdle Rate

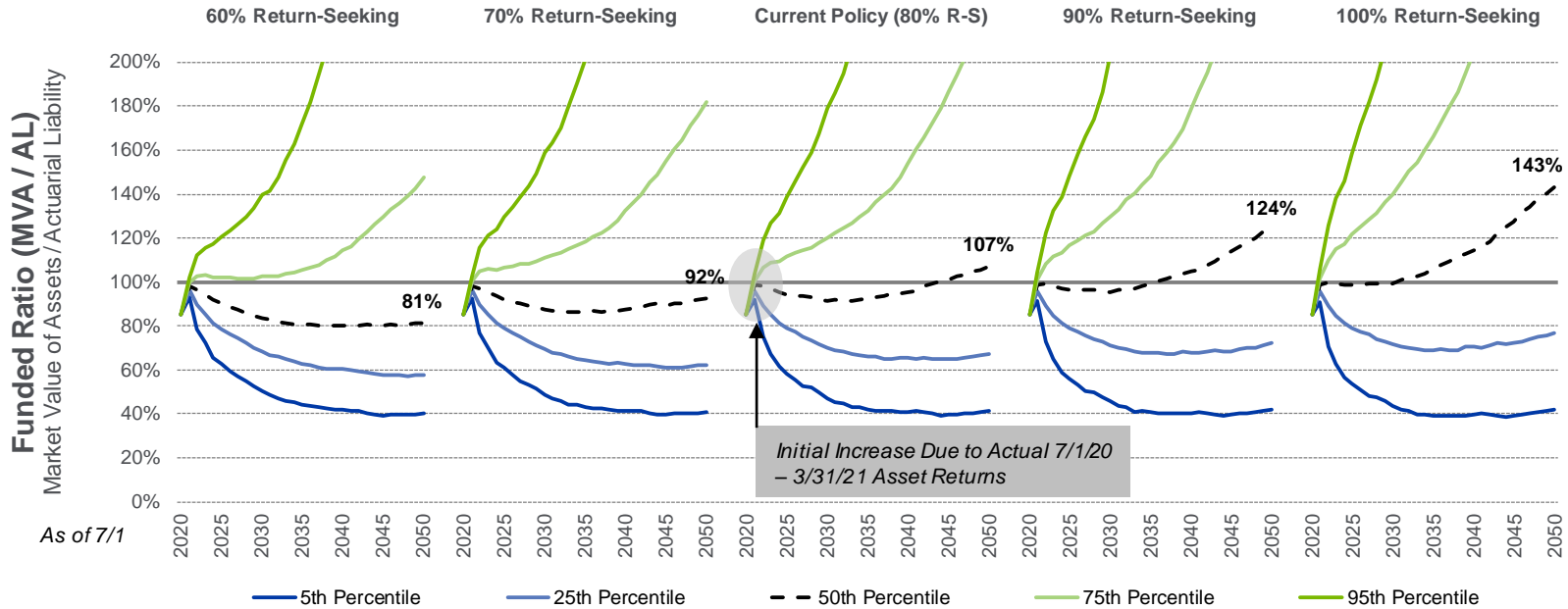
- **Asset Hurdle Rate** is the level of asset growth needed to keep pace with the growth of the Plan liabilities
 - Assets must grow at this rate or more in order to maintain or reduce the existing funding shortfall
- Assets can grow via:
 - Investment performance, and/or
 - Funding contributions
- Asset hurdle rates increase as funded ratio declines, as shown in the chart to the right



Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

State Patrol Retirement System

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	51%	42%	40%	49%	41%	41%	47%	41%	42%	46%	40%	42%	44%	39%	42%
25th Percentile	68%	60%	58%	69%	63%	62%	70%	65%	67%	71%	68%	72%	71%	70%	77%
50th Percentile	84%	80%	81%	88%	87%	92%	92%	95%	107%	95%	105%	124%	99%	114%	143%
75th Percentile	102%	114%	148%	111%	133%	182%	120%	154%	>200%	130%	179%	>200%	140%	>200%	>200%
95th Percentile	140%	>200%	>200%	159%	>200%	>200%	179%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%

Key Takeaways:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 80% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Patrol Retirement System

Funded Ratio Analysis (Based on Market Value of Assets)

The **State Patrol Retirement System** is projected to have the following probability of exceeding key funded ratio thresholds under the Current portfolio mix:

Funded Status	After 5 Years					After 10 Years					After 30 Years				
	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S
100%	29.1%	36.5%	41.5%	45.3%	48.1%	27.0%	35.0%	41.1%	45.7%	49.4%	37.8%	46.1%	52.9%	58.9%	63.2%
90%	50.2%	54.1%	57.5%	59.9%	61.5%	39.9%	46.8%	51.8%	55.7%	58.5%	43.8%	51.5%	58.2%	63.8%	68.0%
80%	71.9%	73.0%	73.6%	73.8%	73.8%	56.0%	61.1%	64.0%	66.0%	67.5%	51.3%	58.4%	64.8%	69.6%	73.4%
70%	88.5%	87.6%	86.4%	85.4%	84.4%	72.7%	74.3%	75.2%	75.7%	75.9%	60.6%	67.2%	72.7%	76.4%	79.4%
60%	96.7%	95.3%	94.3%	92.9%	91.8%	86.5%	86.0%	85.7%	85.0%	84.6%	72.6%	77.2%	80.8%	83.2%	85.1%
50%	99.3%	98.9%	98.2%	97.4%	96.7%	95.2%	94.4%	93.4%	92.4%	91.2%	84.6%	87.3%	89.1%	90.6%	91.4%
40%	100.0%	99.9%	99.7%	99.3%	98.9%	99.2%	98.7%	98.1%	97.3%	96.6%	95.1%	95.5%	95.7%	95.8%	95.9%
30%	100.0%	100.0%	100.0%	100.0%	99.9%	100.0%	99.9%	99.7%	99.4%	99.1%	99.5%	99.4%	99.3%	99.2%	99.1%
20%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%
10%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

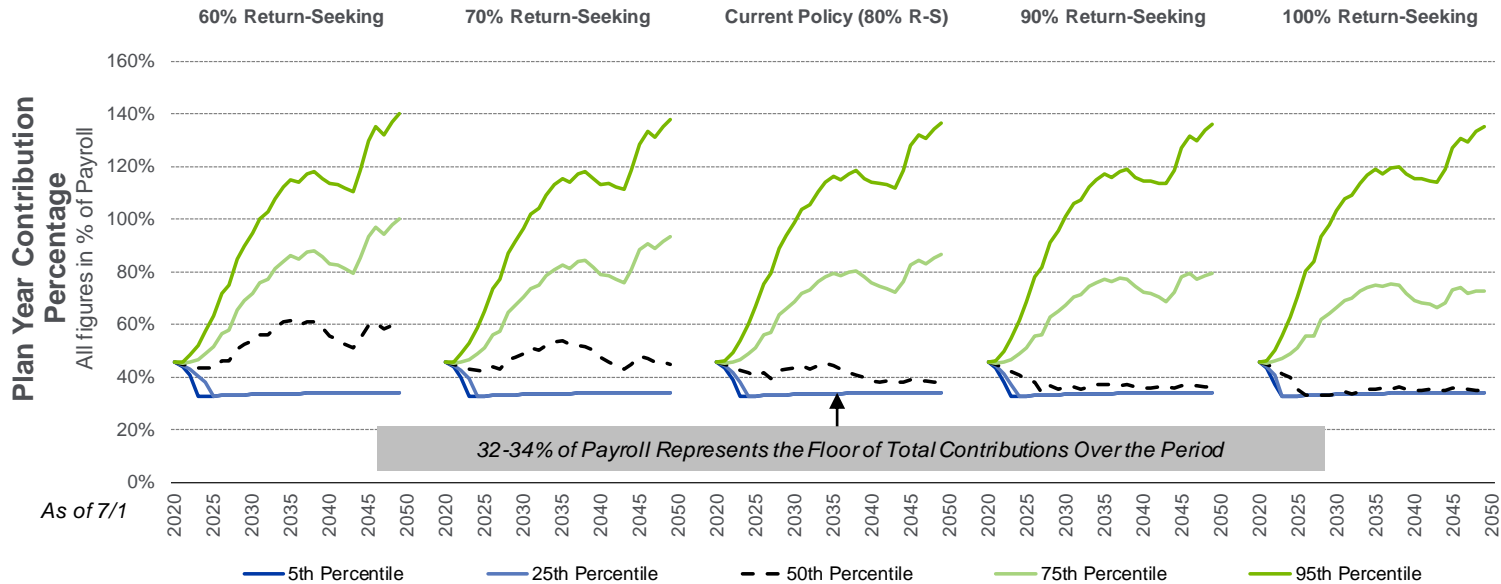
Key Takeaway:

- Higher risk portfolios are projected to have more upside potential over longer periods of time while lower risk portfolios are expected to have higher downside protection in the near-term

Blue = Greater than 50% chance of surpassing a given threshold

State Patrol Retirement System

Total Contribution Percentage of Payroll



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	33%	34%	34%	33%	34%	34%	33%	34%	34%	33%	34%	34%	33%	34%	34%
25th Percentile	33%	34%	34%	33%	34%	34%	33%	34%	34%	33%	34%	34%	33%	34%	34%
50th Percentile	52%	59%	60%	48%	50%	45%	43%	40%	38%	36%	36%	36%	33%	35%	35%
75th Percentile	69%	86%	100%	67%	82%	93%	66%	78%	87%	65%	75%	79%	64%	72%	73%
95th Percentile	90%	116%	140%	92%	115%	138%	94%	115%	137%	96%	116%	136%	98%	117%	135%

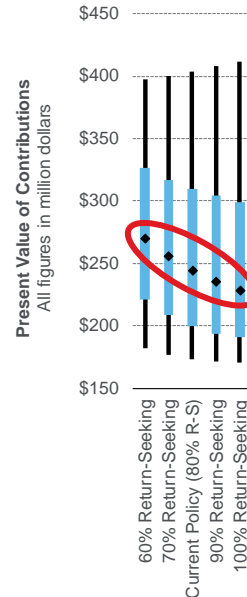
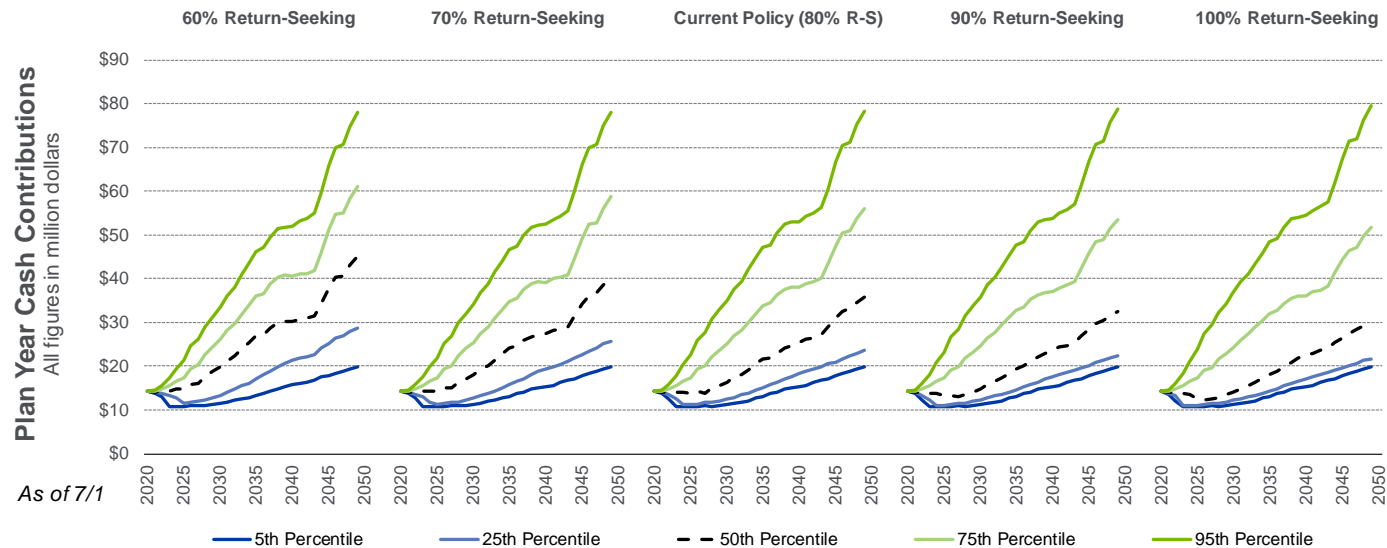
Key Takeaways:

- Total contribution percentages, determined by the actuarial contribution policy, are projected to exceed the current statutory, payroll-based level (32-34%) in the expected case (50th percentile outcome)
- Increases to the return-seeking allocation will lower expected contribution rates (50th percentile outcomes)

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Patrol Retirement System

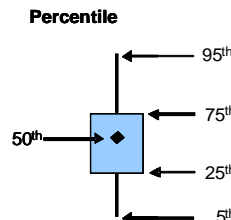
Total Contribution Amount



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	\$11	\$15	\$20	\$11	\$15	\$20	\$11	\$15	\$20	\$11	\$15	\$20	\$11	\$15	\$20
25th Percentile	\$13	\$21	\$29	\$12	\$19	\$26	\$12	\$18	\$24	\$12	\$17	\$22	\$12	\$17	\$22
50th Percentile	\$19	\$30	\$45	\$17	\$27	\$40	\$16	\$25	\$36	\$14	\$23	\$33	\$13	\$22	\$30
75th Percentile	\$24	\$41	\$61	\$24	\$39	\$59	\$24	\$38	\$56	\$23	\$37	\$54	\$23	\$36	\$52
95th Percentile	\$31	\$52	\$78	\$32	\$52	\$78	\$33	\$53	\$78	\$34	\$54	\$79	\$34	\$54	\$80

Key Takeaways:

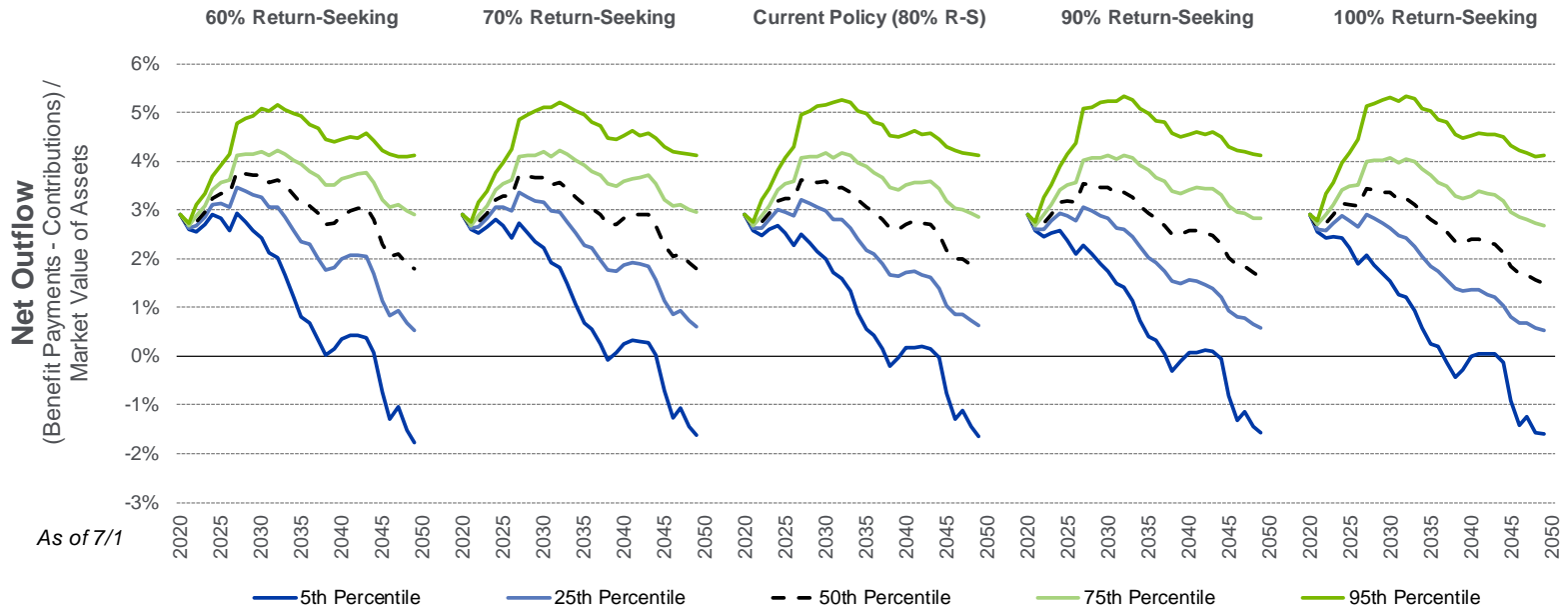
- Contribution amounts are projected to increase over the period with a floor of statutory, payroll-based contributions
- Increases to the return-seeking allocation will lower expected (50th percentile outcomes) while increasing the volatility of those amounts



* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Patrol Retirement System

Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	2.6%	0.2%	-1.8%	2.4%	0.1%	-1.6%	2.1%	0.0%	-1.6%	1.9%	-0.1%	-1.6%	1.7%	-0.3%	-1.6%
25th Percentile	3.3%	1.8%	0.5%	3.2%	1.8%	0.6%	3.1%	1.6%	0.6%	2.9%	1.5%	0.6%	2.7%	1.3%	0.5%
50th Percentile	3.7%	2.7%	1.8%	3.7%	2.7%	1.8%	3.6%	2.6%	1.7%	3.5%	2.5%	1.6%	3.4%	2.3%	1.5%
75th Percentile	4.1%	3.5%	2.9%	4.1%	3.5%	3.0%	4.1%	3.4%	2.9%	4.1%	3.3%	2.8%	4.0%	3.2%	2.7%
95th Percentile	4.9%	4.4%	4.1%	5.0%	4.4%	4.1%	5.1%	4.5%	4.1%	5.2%	4.5%	4.1%	5.3%	4.5%	4.1%
Probability > 10%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Key Takeaway:

- Net outflow is consistent across the policies modeled with central expectations (50th percentile outcome) in the 1-4% range

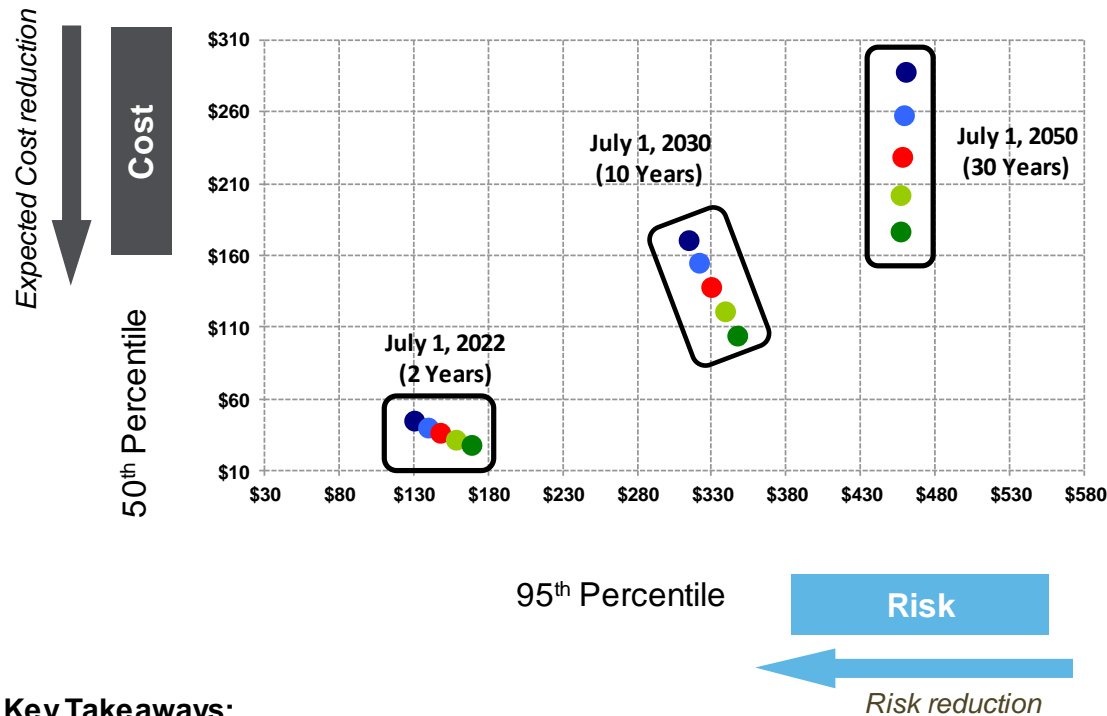
* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Patrol Retirement System

Economic Cost Analysis—2-Year, 10-Year, and 30-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 7.00%, \$millions



Economic Cost		
July 1, 2022		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$43.9	\$131.5
70% Return-Seeking	\$39.9	\$140.1
Current Policy (80% R-S)	\$35.4	\$149.2
90% Return-Seeking	\$31.3	\$159.0
100% Return-Seeking	\$27.0	\$169.1
July 1, 2030		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$169.8	\$315.0
70% Return-Seeking	\$153.5	\$323.0
Current Policy (80% R-S)	\$136.7	\$331.1
90% Return-Seeking	\$120.4	\$339.5
100% Return-Seeking	\$103.6	\$347.7
July 1, 2050		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$286.6	\$461.6
70% Return-Seeking	\$256.7	\$459.6
Current Policy (80% R-S)	\$227.7	\$458.6
90% Return-Seeking	\$201.2	\$457.2
100% Return-Seeking	\$176.2	\$458.0

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- Under the Current Policy over a 30-year time horizon, the expected Economic Cost is \$227.7M and the potential risk is \$458.6M

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied; Reflects a utility function: Excludes 50% of surplus in excess of 120% of Actuarial liability, and includes twice the shortfall below 30% of Actuarial liability, on a market value basis

State Patrol Retirement System

Summary and Conclusions

All Scenarios \$ Millions	30-year Economic Cost		30-year Present Value of Contributions		30-year Ending Funded Ratio (MVA / AL)	
	Expected ¹	Downside ²	Expected ¹	Downside ²	Expected ¹	Downside ³
Current Policy (80% R-S)	\$227.7	\$458.6	\$244.4	\$403.2	107%	42%
Current Frontier of Results						
0% Return-Seeking	\$456.0	\$507.5	\$377.7	\$409.3	46%	32%
10% Return-Seeking	\$433.7	\$493.2	\$360.6	\$400.8	50%	34%
20% Return-Seeking	\$408.1	\$483.5	\$342.3	\$396.6	54%	36%
30% Return-Seeking	\$380.3	\$475.9	\$323.4	\$395.3	59%	37%
40% Return-Seeking	\$349.0	\$470.4	\$305.0	\$396.0	65%	38%
50% Return-Seeking	\$318.1	\$465.5	\$286.7	\$396.6	72%	39%
60% Return-Seeking	\$286.6	\$461.6	\$269.8	\$397.1	81%	40%
70% Return-Seeking	\$256.7	\$459.6	\$255.9	\$400.2	92%	41%
80% Return-Seeking	\$227.7	\$458.6	\$244.4	\$403.2	107%	42%
90% Return-Seeking	\$201.2	\$457.2	\$235.4	\$408.0	124%	42%
100% Return-Seeking	\$176.2	\$458.0	\$228.9	\$411.1	143%	42%

Key Findings:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 80% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

¹ Expected = 50th percentile outcome or central expectation across all 5,000 simulations

² Downside = 95th percentile outcome across all 5,000 simulations

³ Downside = 5th percentile outcome across all 5,000 simulations



Additional Analysis

- Judges Retirement System

Judges Retirement System

Current State Asset-Liability Profile As of July 1, 2020

Asset-Liability Snapshot as of 7/1/2020		
Metric (\$, Millions)	Value	Fund %
Market Value of Assets	\$194.5	94.2%
Actuarial Value of Assets	\$201.0	97.3%
Liability Metrics		
Actuarial Liability (AL) - Funding	\$206.5 ¹	

Asset-Liability Growth Metrics			
Metric (\$, Millions)	Value	% Liability	% Assets
AL Discount Cost	\$15.5	7.50%	7.96%
AL Normal Cost	\$5.3	2.58%	2.74%
Total Liability Hurdle Rate	\$20.8	10.08%	10.70%
Expected Return on Assets ²	\$12.3	5.95%	6.31%
Total Contributions	\$5.8	2.79%	2.96%
Total Exp. Asset Growth	\$18.0	8.74%	9.27%
Hurdle Rate Shortfall/(Surplus)	\$2.8	1.34%	1.43%
Est. Benefit Payments	\$13.3	6.42%	6.82%

¹ Based on a 7.50% discount rate consistent with the July 1, 2020 valuation results.

² Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions.

Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

Percentages may not sum to 100% due to rounding.

Key Takeaways:

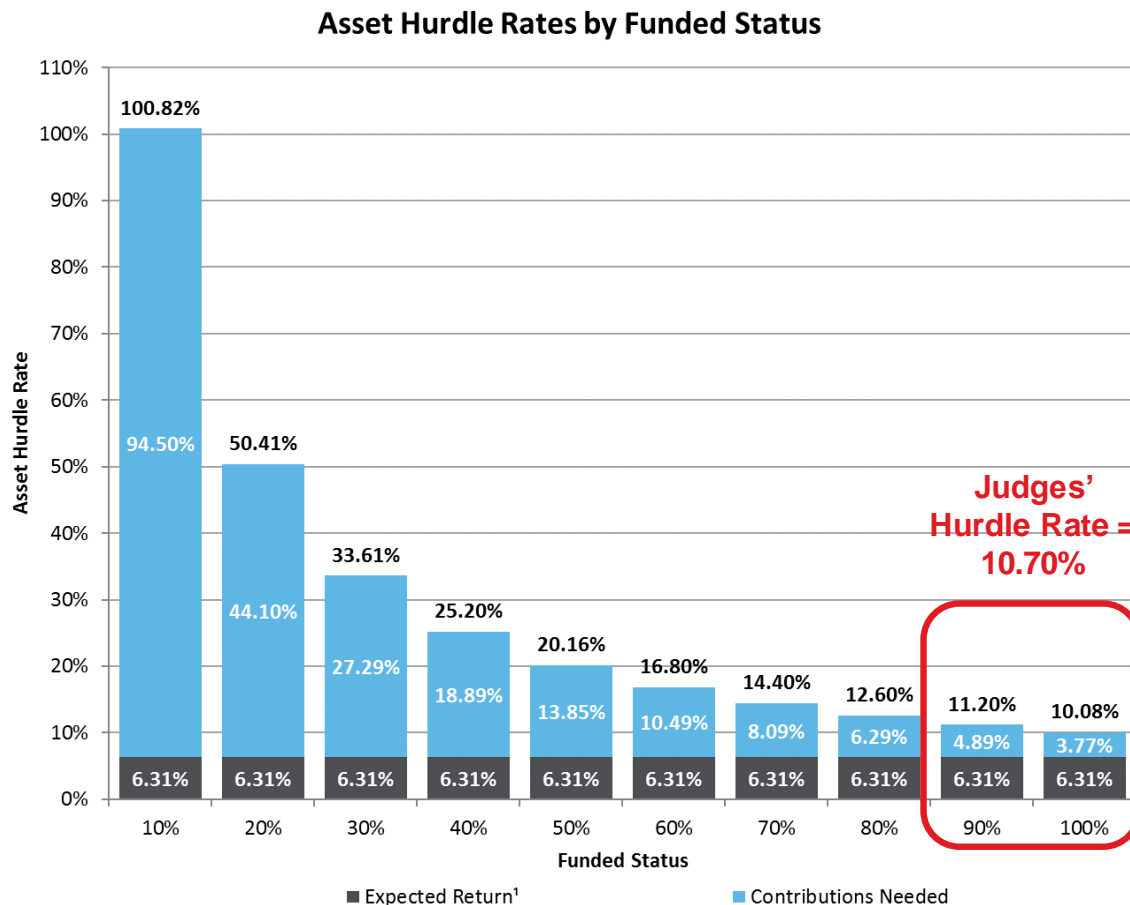
- Pension plan is 94.2% funded on a market value of assets basis as of July 1, 2020
- Asset allocation is 80% return-seeking assets with 20% risk-reducing/safety assets to withstand stressed markets
- Asset hurdle rate of 10.70%, via cash funding and investment returns, needed to maintain or improve actuarial funded status

Target Asset Allocation as of 7/1/2020		
Metric (\$, Millions)	Value	Alloc %
Return-Seeking		
- U.S. Equity	\$52.5	27%
- International Equity	\$22.4	12%
- Global Equity	\$37.0	19%
- Private Equity	\$9.7	5%
- Real Estate	\$14.6	8%
- Non-Core Bonds	\$19.5	10%
- Total	\$155.6	80%
Risk-Reducing		
- Core Bonds	\$38.9	20%
- Total	\$38.9	20%
Total	\$194.5	100%

Judges Retirement System

Asset Hurdle Rate

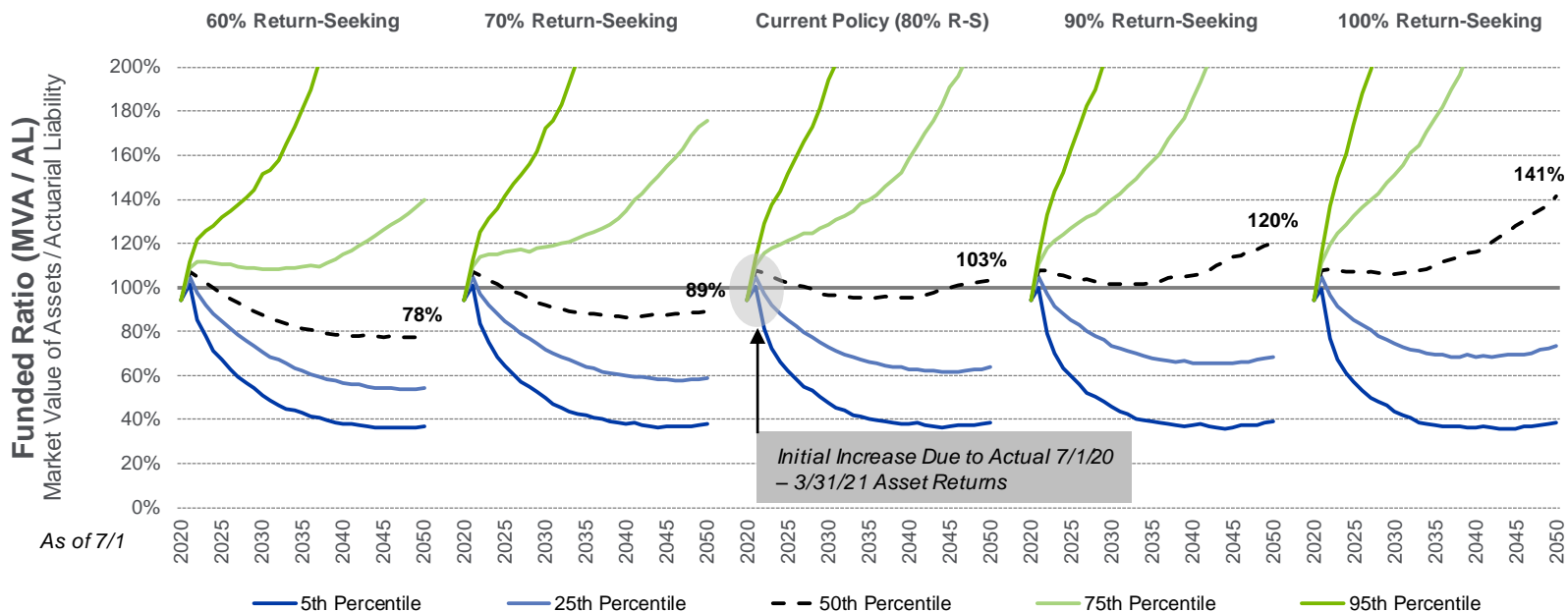
- **Asset Hurdle Rate** is the level of asset growth needed to keep pace with the growth of the Plan liabilities
 - Assets must grow at this rate or more in order to maintain or reduce the existing funding shortfall
- Assets can grow via:
 - Investment performance, and/or
 - Funding contributions
- Asset hurdle rates increase as funded ratio declines, as shown in the chart to the right



Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

Judges Retirement System

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	51%	38%	37%	50%	38%	38%	48%	38%	39%	46%	37%	39%	44%	36%	39%
25th Percentile	71%	57%	54%	72%	60%	59%	73%	63%	64%	74%	66%	68%	74%	68%	73%
50th Percentile	87%	79%	78%	92%	86%	89%	97%	95%	103%	101%	105%	120%	106%	116%	141%
75th Percentile	108%	115%	140%	118%	135%	176%	129%	158%	>200%	140%	186%	>200%	151%	>200%	>200%
95th Percentile	152%	>200%	>200%	172%	>200%	>200%	194%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%

Key Takeaways:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 80% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

Judges Retirement System

Funded Ratio Analysis (Based on Market Value of Assets)

The **Judges Retirement System** is projected to have the following probability of exceeding key funded ratio thresholds under the Current portfolio mix:

Funded Status	After 5 Years					After 10 Years					After 30 Years				
	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S
100%	44.4%	49.3%	53.0%	55.8%	58.1%	33.4%	41.0%	46.8%	51.2%	54.6%	35.7%	44.1%	51.7%	57.4%	62.0%
90%	64.3%	66.5%	68.0%	69.2%	69.8%	46.6%	52.4%	56.9%	60.1%	62.5%	41.0%	49.3%	56.3%	61.8%	66.2%
80%	82.0%	81.4%	80.6%	80.1%	79.7%	61.7%	65.4%	67.9%	69.6%	70.8%	48.2%	55.9%	62.2%	67.5%	71.3%
70%	93.1%	91.6%	90.3%	89.2%	88.3%	75.5%	76.7%	77.7%	78.0%	78.3%	56.6%	63.7%	69.5%	73.7%	77.2%
60%	98.1%	97.1%	96.0%	94.9%	93.8%	88.3%	87.6%	87.1%	86.4%	85.9%	67.7%	73.9%	77.6%	80.9%	83.1%
50%	99.7%	99.2%	98.8%	98.1%	97.4%	95.6%	94.8%	93.8%	92.9%	91.8%	80.1%	84.1%	86.3%	87.9%	89.0%
40%	100.0%	99.9%	99.8%	99.5%	99.1%	99.2%	98.7%	97.9%	97.2%	96.5%	92.4%	93.6%	94.2%	94.3%	94.5%
30%	100.0%	100.0%	100.0%	100.0%	99.9%	99.9%	99.9%	99.7%	99.3%	99.0%	98.8%	98.7%	98.7%	98.7%	98.5%
20%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%	100.0%	100.0%	99.9%	99.9%	99.9%
10%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

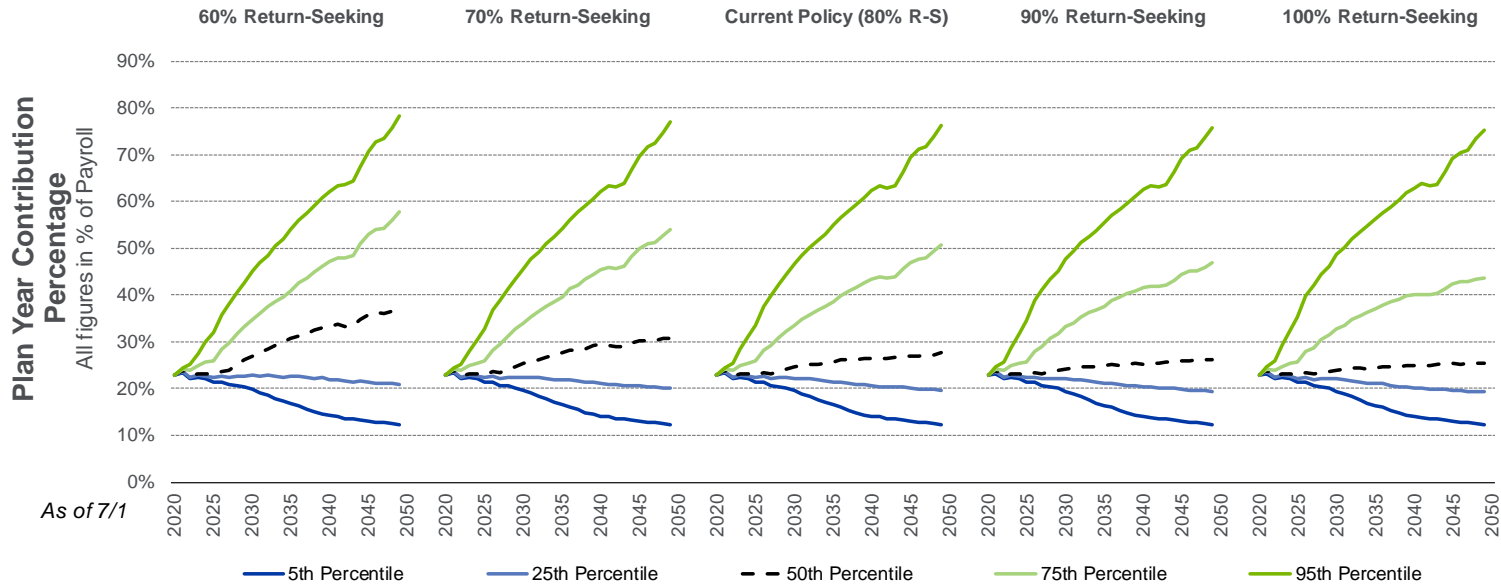
Key Takeaway:

- Higher risk portfolios are projected to have more upside potential over longer periods of time while lower risk portfolios are expected to have higher downside protection in the near-term

Blue = Greater than 50% chance of surpassing a given threshold

Judges Retirement System

Total Contribution Percentage of Payroll



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	20%	14%	12%	20%	14%	12%	20%	14%	12%	20%	14%	12%	20%	14%	12%
25th Percentile	23%	22%	21%	22%	21%	20%	22%	21%	20%	22%	21%	19%	22%	20%	19%
50th Percentile	26%	33%	37%	25%	29%	31%	24%	26%	28%	24%	25%	26%	24%	25%	25%
75th Percentile	33%	46%	58%	33%	44%	54%	32%	43%	51%	32%	41%	47%	32%	40%	44%
95th Percentile	43%	61%	78%	43%	61%	77%	44%	61%	76%	45%	61%	76%	46%	62%	75%

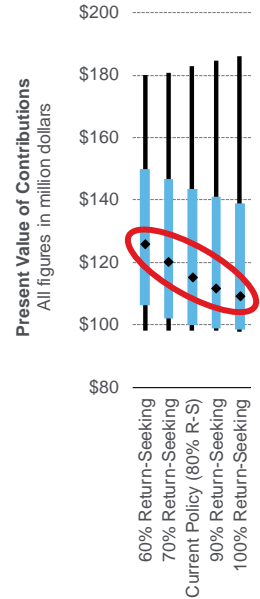
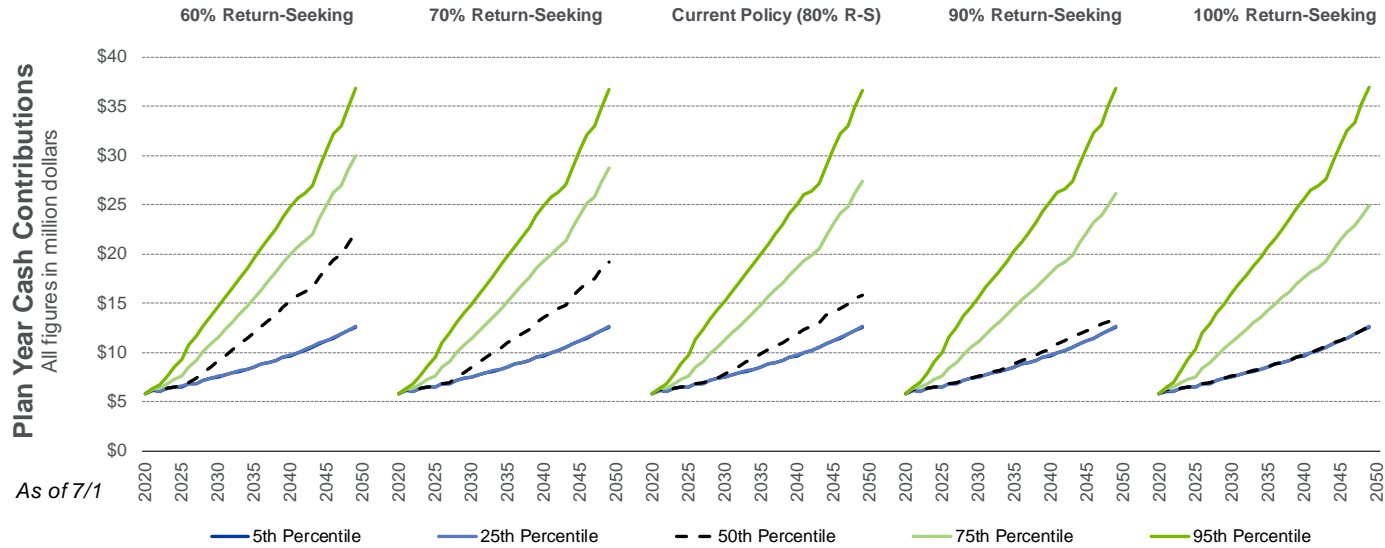
Key Takeaway:

- Contribution percentages, determined by the actuarial contribution, are projected to exceed the anticipated court fees plus the employee, payroll-based contributions in the central expectation (50th percentile)

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

Judges Retirement System

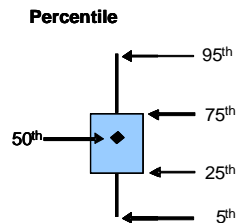
Total Contribution Amount



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	\$7	\$9	\$13	\$7	\$9	\$13	\$7	\$9	\$13	\$7	\$9	\$13	\$7	\$9	\$13
25th Percentile	\$7	\$10	\$13	\$7	\$9	\$13	\$7	\$9	\$13	\$7	\$9	\$13	\$7	\$9	\$13
50th Percentile	\$9	\$15	\$22	\$8	\$13	\$19	\$7	\$11	\$16	\$7	\$10	\$13	\$7	\$10	\$13
75th Percentile	\$11	\$19	\$30	\$11	\$18	\$29	\$11	\$18	\$27	\$10	\$17	\$26	\$10	\$17	\$25
95th Percentile	\$14	\$24	\$37	\$14	\$24	\$37	\$14	\$24	\$37	\$15	\$24	\$37	\$15	\$25	\$37

Key Takeaways:

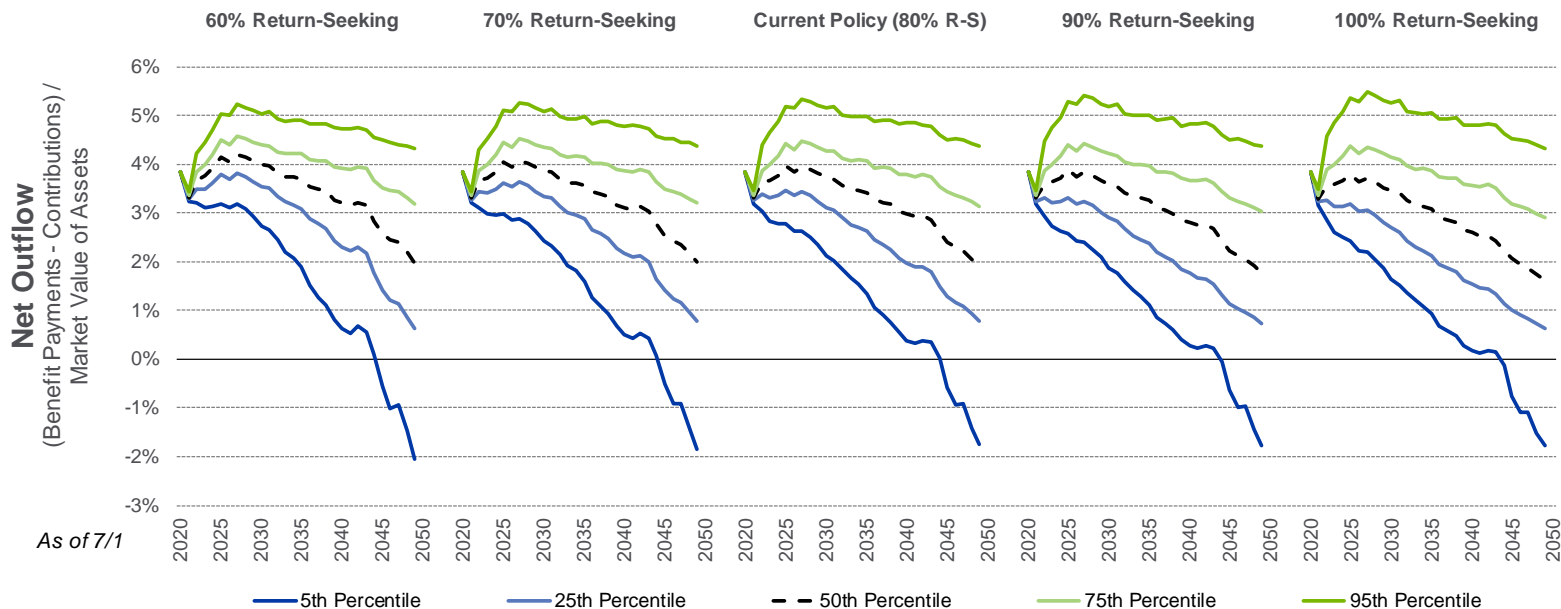
- Contribution amounts are projected to increase over the period with a floor of statutory, payroll-based employee contributions plus expected court fees
- Higher (or lower) return-seeking strategies adjust the central trend lines



* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

Judges Retirement System

Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	2.9%	0.8%	-2.0%	2.6%	0.7%	-1.8%	2.3%	0.6%	-1.8%	2.1%	0.4%	-1.8%	1.9%	0.3%	-1.8%
25th Percentile	3.6%	2.4%	0.6%	3.4%	2.3%	0.8%	3.2%	2.1%	0.8%	3.0%	1.8%	0.7%	2.8%	1.6%	0.6%
50th Percentile	4.1%	3.3%	2.0%	3.9%	3.2%	2.0%	3.8%	3.0%	1.9%	3.7%	2.9%	1.8%	3.5%	2.7%	1.6%
75th Percentile	4.5%	3.9%	3.2%	4.4%	3.9%	3.2%	4.3%	3.8%	3.1%	4.3%	3.7%	3.0%	4.2%	3.6%	2.9%
95th Percentile	5.1%	4.7%	4.3%	5.2%	4.8%	4.4%	5.2%	4.8%	4.4%	5.2%	4.8%	4.4%	5.3%	4.8%	4.3%
Probability > 10%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Key Takeaway:

- Net outflow is consistent across the policies modeled with central expectations (50th percentile outcome) in the 2-4% range

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

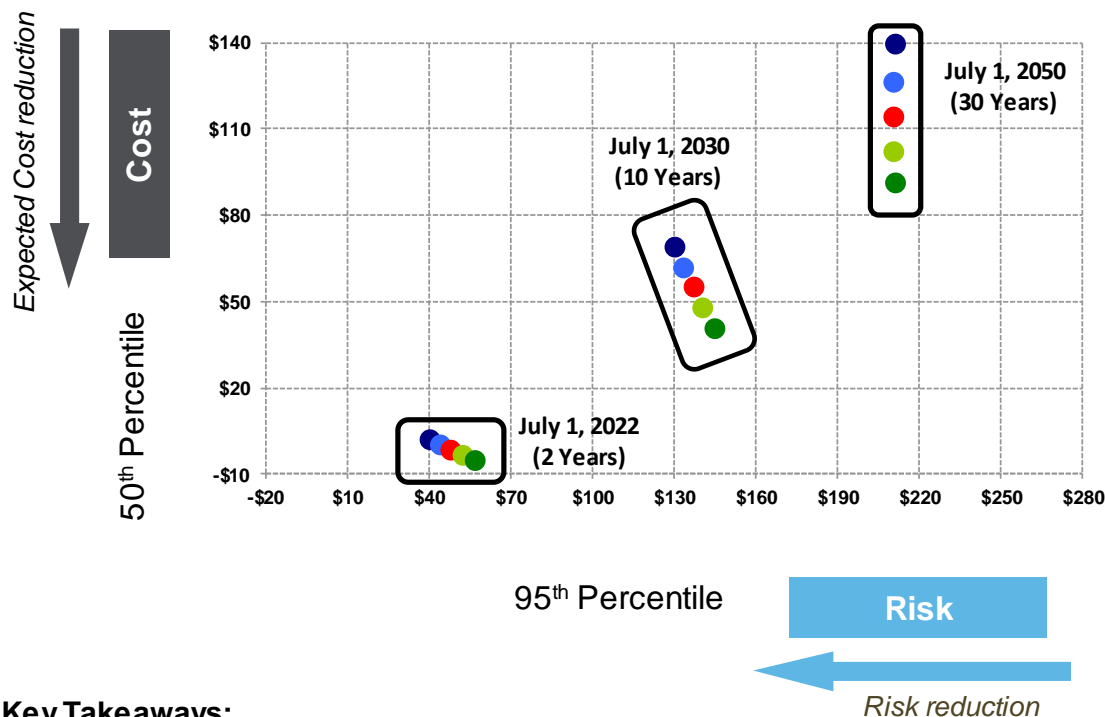
Proprietary & Confidential
Investment advice and consulting services provided by Aon Investments USA Inc.

Judges Retirement System

Economic Cost Analysis—2-Year, 10-Year, and 30-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 7.00%, \$millions



Economic Cost		
July 1, 2022		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$1.9	\$40.5
70% Return-Seeking	\$0.1	\$44.3
Current Policy (80% R-S)	(\$1.9)	\$48.3
90% Return-Seeking	(\$3.7)	\$52.6
100% Return-Seeking	(\$5.6)	\$57.1
July 1, 2030		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$68.4	\$130.7
70% Return-Seeking	\$61.4	\$134.1
Current Policy (80% R-S)	\$54.6	\$137.4
90% Return-Seeking	\$47.5	\$140.9
100% Return-Seeking	\$40.5	\$145.3
July 1, 2050		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$139.0	\$211.8
70% Return-Seeking	\$126.1	\$210.9
Current Policy (80% R-S)	\$113.8	\$211.0
90% Return-Seeking	\$101.8	\$211.2
100% Return-Seeking	\$91.1	\$211.6

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- Under the Current Policy over a 30-year time horizon, the expected Economic Cost is \$113.8M and the potential risk is \$211.0M

* Liability projections assume discount rates of 7.50% (for 2020), 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied; Reflects a *utility function*: Excludes 50% of surplus in excess of 130% of Actuarial liability, and includes twice the shortfall below 40% of Actuarial liability, on a market value basis

Judges Retirement System

Summary and Conclusions

All Scenarios \$ Millions	30-year Economic Cost		30-year Present Value of Contributions		30-year Ending Funded Ratio (MVA / AL)	
	Expected ¹	Downside ²	Expected ¹	Downside ²	Expected ¹	Downside ³
Current Policy (80% R-S)	\$113.8	\$211.0	\$115.3	\$182.7	103%	39%
Current Frontier of Results						
0% Return-Seeking	\$208.0	\$233.1	\$171.0	\$183.2	42%	28%
10% Return-Seeking	\$198.3	\$226.2	\$164.0	\$179.8	45%	30%
20% Return-Seeking	\$187.6	\$221.1	\$156.2	\$178.2	49%	32%
30% Return-Seeking	\$176.3	\$217.0	\$148.4	\$178.0	54%	33%
40% Return-Seeking	\$164.3	\$214.5	\$140.6	\$178.5	60%	35%
50% Return-Seeking	\$152.1	\$212.7	\$132.9	\$178.9	68%	36%
60% Return-Seeking	\$139.0	\$211.8	\$126.1	\$180.0	78%	37%
70% Return-Seeking	\$126.1	\$210.9	\$120.2	\$180.8	89%	38%
80% Return-Seeking	\$113.8	\$211.0	\$115.3	\$182.7	103%	39%
90% Return-Seeking	\$101.8	\$211.2	\$111.8	\$184.5	120%	39%
100% Return-Seeking	\$91.1	\$211.6	\$109.4	\$186.1	141%	39%

Key Findings:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 80% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

¹ Expected = 50th percentile outcome or central expectation across all 5,000 simulations

² Downside = 95th percentile outcome across all 5,000 simulations

³ Downside = 5th percentile outcome across all 5,000 simulations



Additional Analysis

- State Cash Balance Plan

State Cash Balance Plan

Current State Asset-Liability Profile As of January 1, 2021

Asset-Liability Snapshot as of 1/1/2021		
Metric (\$, Millions)	Value	Fund %
Market Value of Assets	\$1,991.7	110.9%
Actuarial Value of Assets	\$1,868.8	104.1%
Liability Metrics		
Actuarial Liability (AL) - Funding	\$1,795.4 ¹	

Asset-Liability Growth Metrics			
Metric (\$, Millions)	Value	% Liability	% Assets
AL Discount Cost	\$131.1	7.30%	6.58%
AL Normal Cost	\$67.7	3.77%	3.40%
Total Liability Hurdle Rate	\$198.8	11.07%	9.98%
Expected Return on Assets ²	\$125.7	7.00%	6.31%
Total Contributions	\$86.7	4.83%	4.35%
Total Exp. Asset Growth	\$212.5	11.83%	10.66%
Hurdle Rate Shortfall/(Surplus)	-\$13.7	-0.76%	-0.68%
Est. Benefit Payments	\$125.2	6.97%	6.28%

¹ Based on a 7.30% discount rate consistent with the January 1, 2021 valuation results.

² Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions.

Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

Percentages may not sum to 100% due to rounding.

Key Takeaways:

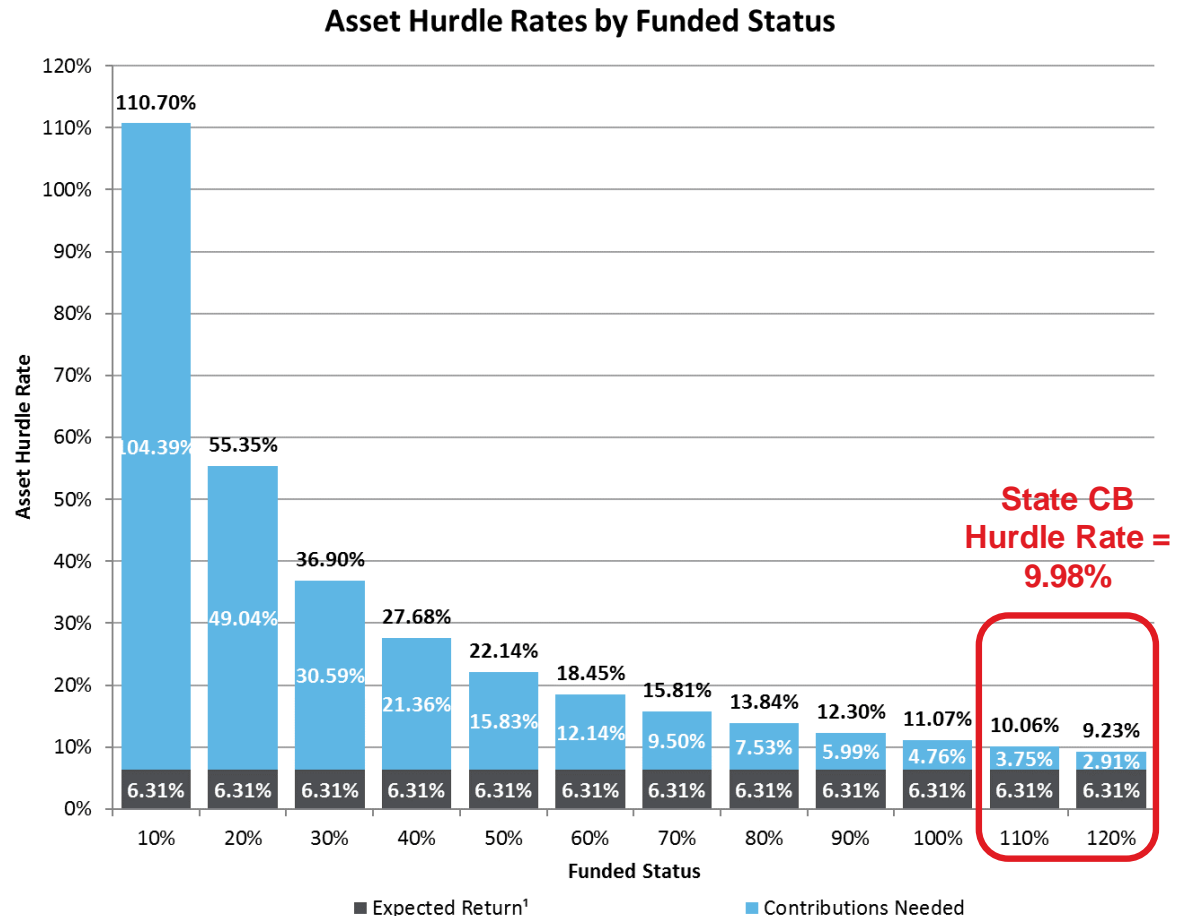
- Pension plan is 110.9% funded on a market value of assets basis as of January 1, 2021
- Asset allocation is 80% return-seeking assets with 20% risk-reducing/safety assets to withstand stressed markets
- Asset hurdle rate of 9.98%, via cash funding and investment returns, needed to maintain or improve actuarial funded status

Target Asset Allocation as of 1/1/2021		
Metric (\$, Millions)	Value	Alloc %
Return-Seeking		
- U.S. Equity	\$537.8	27%
- International Equity	\$229.0	12%
- Global Equity	\$378.4	19%
- Private Equity	\$99.6	5%
- Real Estate	\$149.4	8%
- Non-Core Bonds	\$199.2	10%
- Total	\$1,593.4	80%
Risk-Reducing		
- Core Bonds	\$398.3	20%
- Total	\$398.3	20%
Total	\$1,991.7	100%

State Cash Balance Plan

Asset Hurdle Rate

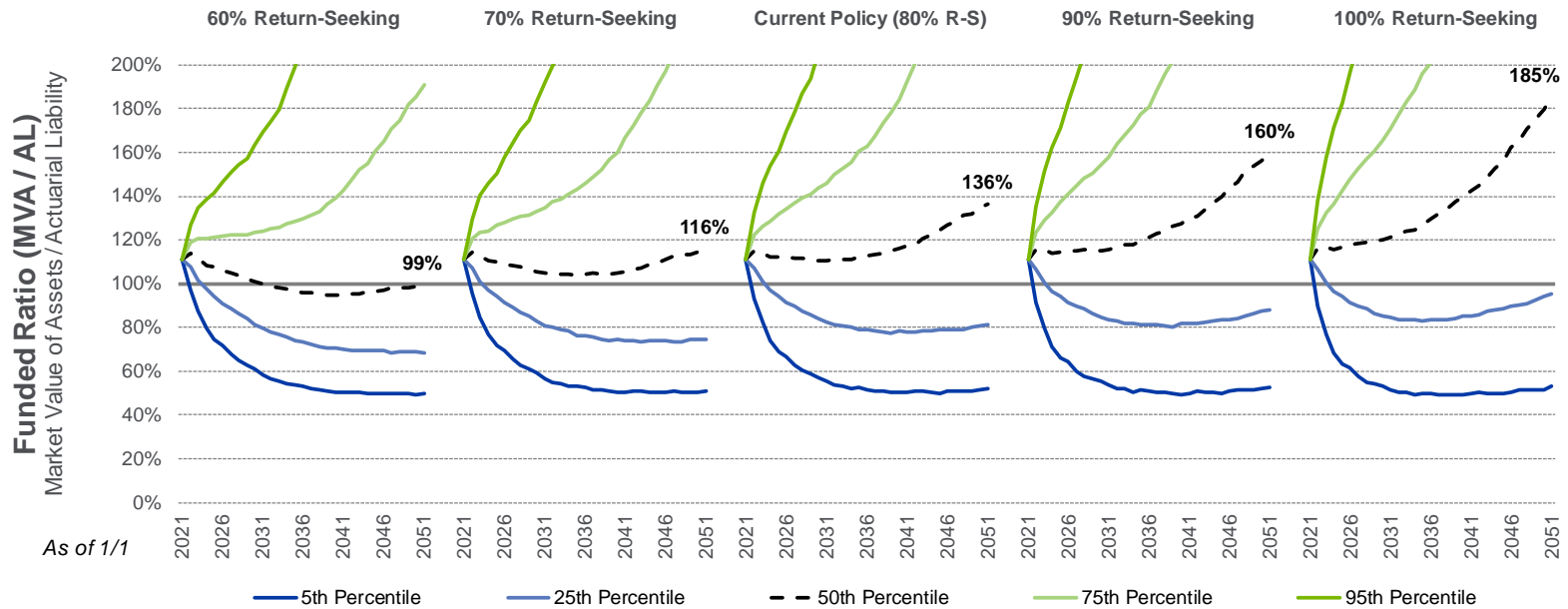
- **Asset Hurdle Rate** is the level of asset growth needed to keep pace with the growth of the Plan liabilities
 - Assets must grow at this rate or more in order to maintain or increase the existing funding surplus
- Assets can grow via:
 - Investment performance, and/or
 - Funding contributions
- Asset hurdle rates increase as funded ratio declines, as shown in the chart to the right



Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

State Cash Balance Plan

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2031	2041	2051	2031	2041	2051	2031	2041	2051	2031	2041	2051	2031	2041	2051
5th Percentile	58%	50%	50%	57%	50%	51%	55%	51%	52%	54%	50%	52%	51%	50%	53%
25th Percentile	79%	70%	69%	81%	74%	75%	82%	78%	81%	83%	82%	88%	84%	85%	95%
50th Percentile	100%	95%	99%	105%	105%	116%	110%	117%	136%	116%	130%	160%	121%	143%	185%
75th Percentile	124%	143%	191%	135%	166%	>200%	146%	192%	>200%	158%	>200%	>200%	170%	>200%	>200%
95th Percentile	170%	>200%	>200%	192%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%

Key Takeaways:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period at allocations above ~60% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Cash Balance Plan

Funded Ratio Analysis (Based on Market Value of Assets)

The **State Cash Balance Plan** is projected to have the following probability of exceeding key funded ratio thresholds under the Current portfolio mix:

Funded Status	After 5 Years					After 10 Years					After 30 Years				
	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S
100%	60.8%	63.5%	65.6%	66.8%	67.6%	49.4%	55.6%	59.4%	62.0%	64.2%	49.8%	57.0%	63.7%	69.2%	73.0%
90%	76.3%	76.3%	76.2%	76.3%	76.2%	62.4%	66.5%	68.7%	70.1%	71.2%	55.2%	62.9%	69.5%	73.9%	77.3%
80%	88.5%	87.3%	86.0%	85.1%	84.1%	74.3%	75.8%	77.0%	77.5%	77.7%	63.9%	70.5%	75.6%	79.5%	82.4%
70%	95.9%	94.5%	93.3%	92.1%	90.9%	86.1%	85.8%	85.5%	85.1%	84.8%	73.7%	79.1%	83.0%	85.5%	87.1%
60%	98.8%	98.2%	97.2%	96.3%	95.4%	94.0%	93.3%	92.5%	91.7%	90.9%	85.0%	88.2%	90.1%	91.5%	92.4%
50%	99.9%	99.6%	99.2%	98.7%	98.1%	98.5%	98.1%	97.2%	96.5%	95.6%	94.8%	95.5%	95.7%	95.8%	95.9%
40%	100.0%	100.0%	100.0%	99.7%	99.4%	99.9%	99.7%	99.4%	99.0%	98.6%	99.3%	99.3%	99.2%	99.0%	98.7%
30%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%	99.8%	100.0%	100.0%	99.9%	99.9%	99.9%
20%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
10%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

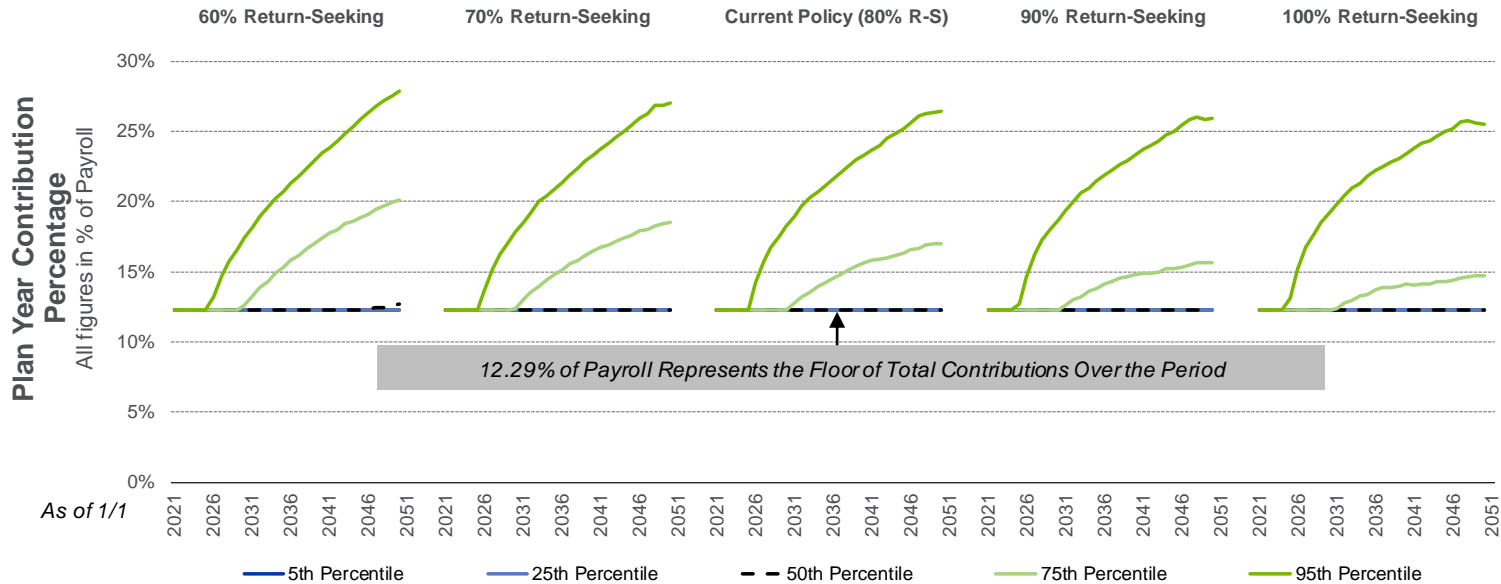
Key Takeaway:

- Higher risk portfolios are projected to have more upside potential over longer periods of time while lower risk portfolios are expected to have higher downside protection in the near-term

Blue = Greater than 50% chance of surpassing a given threshold

State Cash Balance Plan

Total Contribution Percentage of Payroll



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
25th Percentile	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
50th Percentile	12%	12%	13%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
75th Percentile	13%	17%	20%	12%	17%	18%	12%	16%	17%	12%	15%	16%	12%	14%	15%
95th Percentile	17%	23%	28%	18%	23%	27%	18%	23%	26%	19%	23%	26%	19%	23%	26%

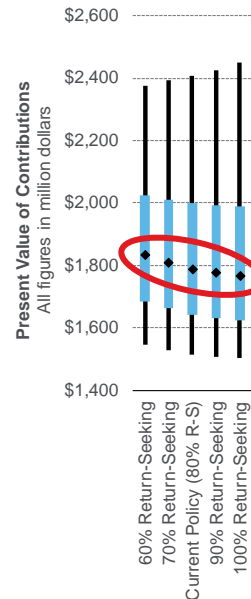
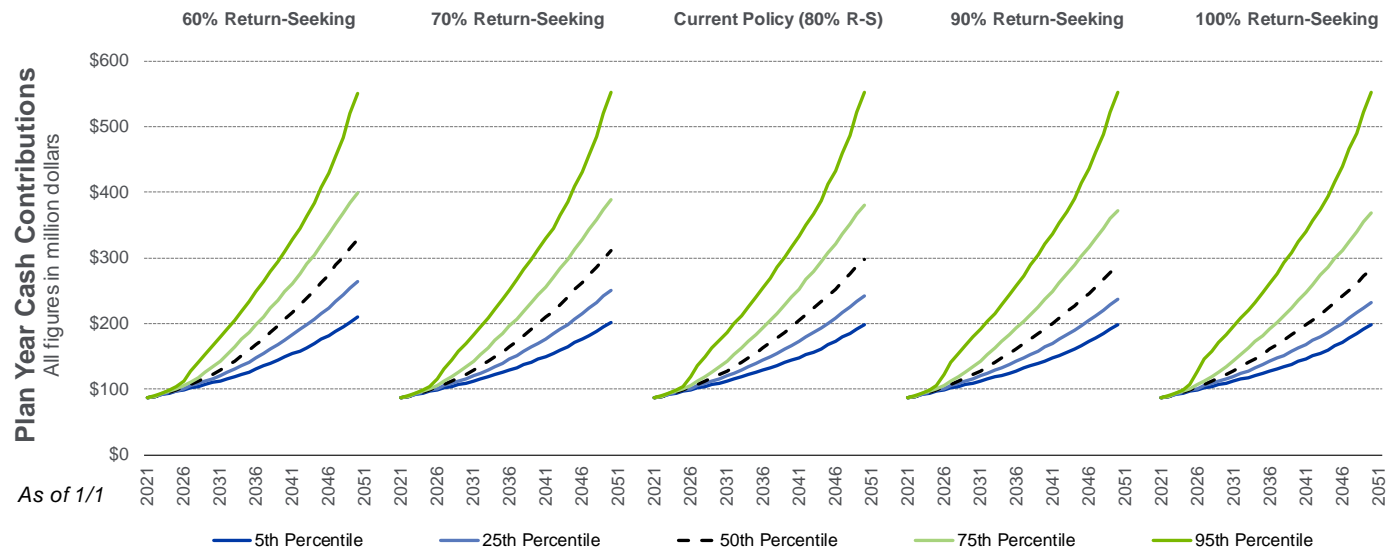
Key Takeaways:

- Total contribution percentages (Employee + Employer) are not expected to be above the statutory amount (12.29%) in our central expectation (50th percentile outcomes) across investment strategies
- Statutory amounts being greater than the actuarially-determined amount is advancing funding into the Plan

* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Cash Balance Plan

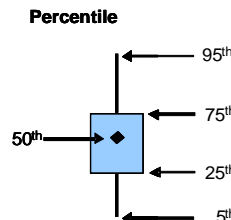
Total Contribution Amount



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	\$110	\$149	\$209	\$110	\$146	\$201	\$110	\$144	\$199	\$109	\$143	\$199	\$109	\$142	\$198
25th Percentile	\$116	\$175	\$264	\$116	\$170	\$251	\$116	\$167	\$243	\$116	\$164	\$236	\$116	\$163	\$232
50th Percentile	\$123	\$206	\$328	\$123	\$200	\$311	\$123	\$195	\$298	\$122	\$192	\$289	\$122	\$190	\$283
75th Percentile	\$134	\$248	\$399	\$134	\$243	\$389	\$134	\$240	\$380	\$134	\$237	\$373	\$134	\$235	\$368
95th Percentile	\$166	\$310	\$550	\$170	\$313	\$552	\$175	\$317	\$553	\$179	\$321	\$553	\$183	\$324	\$553

Key Takeaways:

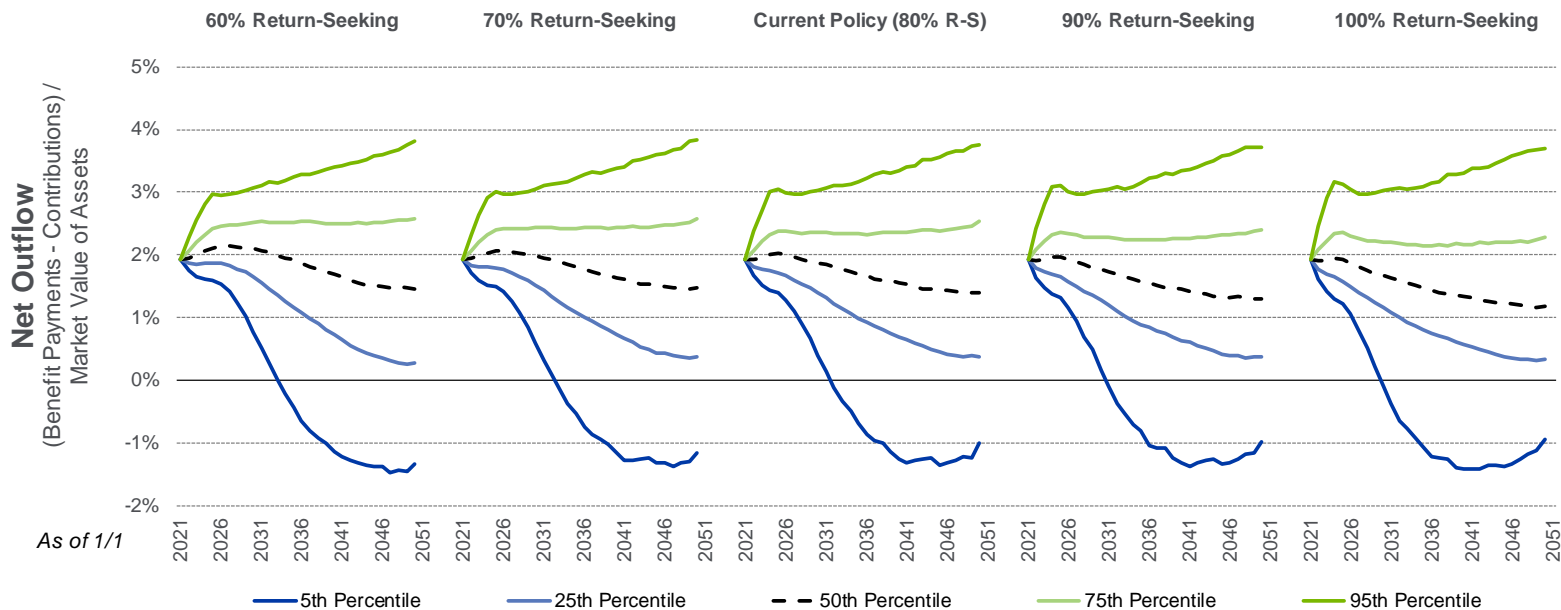
- Contribution amounts are projected to increase over the period with a floor of statutory, payroll-based contributions
- Increases to the return-seeking allocation will lower expected (50th percentile outcomes) while increasing the volatility of those amounts



* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Cash Balance Plan

Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	0.8%	-1.1%	-1.3%	0.6%	-1.2%	-1.2%	0.4%	-1.3%	-1.0%	0.2%	-1.3%	-1.0%	-0.1%	-1.4%	-1.0%
25th Percentile	1.6%	0.7%	0.3%	1.5%	0.7%	0.4%	1.4%	0.7%	0.4%	1.3%	0.6%	0.4%	1.2%	0.6%	0.3%
50th Percentile	2.1%	1.7%	1.5%	2.0%	1.6%	1.5%	1.9%	1.5%	1.4%	1.8%	1.4%	1.3%	1.7%	1.3%	1.2%
75th Percentile	2.5%	2.5%	2.6%	2.4%	2.4%	2.6%	2.4%	2.4%	2.5%	2.3%	2.3%	2.4%	2.2%	2.2%	2.3%
95th Percentile	3.1%	3.4%	3.8%	3.0%	3.4%	3.8%	3.0%	3.3%	3.7%	3.0%	3.3%	3.7%	3.0%	3.3%	3.7%
Probability > 10%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Key Takeaway:

- Net outflow is consistent across the policies modeled with central expectations (50th percentile outcome) in the 1-3% range

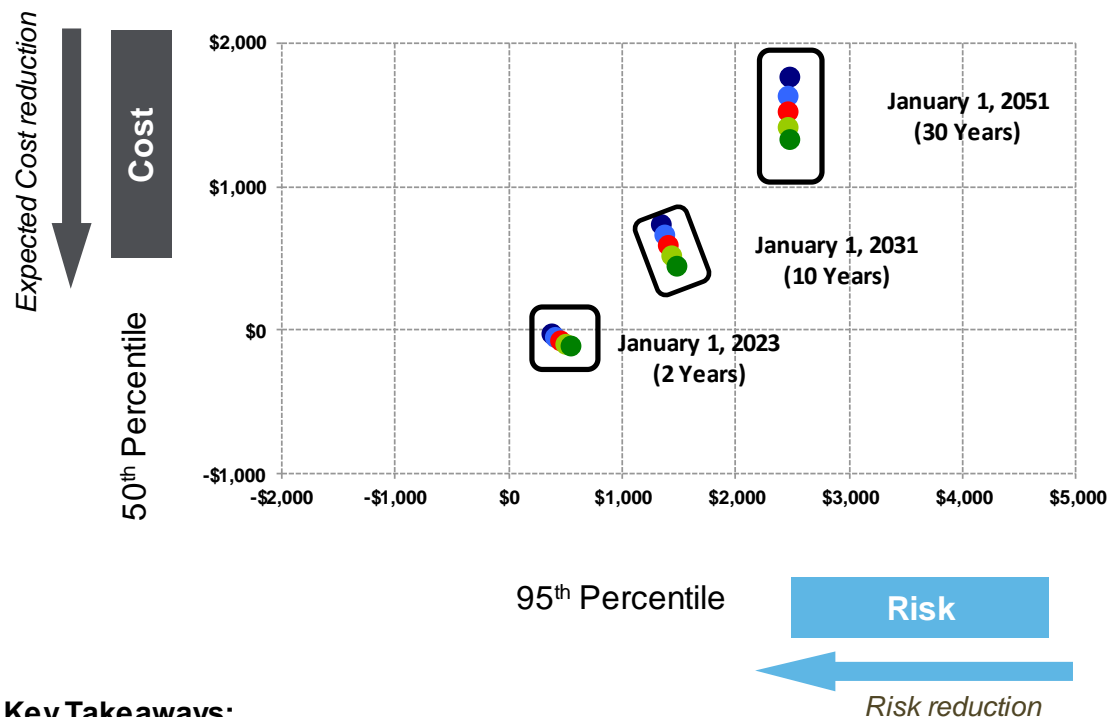
* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

State Cash Balance Plan

Economic Cost Analysis—2-Year, 10-Year, and 30-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 7.00%, \$millions



Economic Cost		
January 1, 2023		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	(\$32.4)	\$381.7
70% Return-Seeking	(\$56.1)	\$424.4
Current Policy (80% R-S)	(\$77.5)	\$468.5
90% Return-Seeking	(\$99.0)	\$514.2
100% Return-Seeking	(\$119.7)	\$559.1
January 1, 2031		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$733.0	\$1,347.6
70% Return-Seeking	\$661.6	\$1,375.8
Current Policy (80% R-S)	\$585.5	\$1,412.0
90% Return-Seeking	\$515.3	\$1,446.4
100% Return-Seeking	\$442.1	\$1,484.1
January 1, 2051		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$1,754.4	\$2,488.8
70% Return-Seeking	\$1,625.8	\$2,474.3
Current Policy (80% R-S)	\$1,509.9	\$2,469.3
90% Return-Seeking	\$1,401.1	\$2,470.6
100% Return-Seeking	\$1,316.6	\$2,482.6

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- Under the Current Policy over a 30-year time horizon, the expected Economic Cost is \$1,509.9M and the potential risk is \$2,469.3M

* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied; Reflects a utility function: Excludes 50% of surplus in excess of 130% of Actuarial liability, and includes twice the shortfall below 40% of Actuarial liability, on a market value basis

State Cash Balance Plan

Summary and Conclusions

All Scenarios \$ Millions	30-year Economic Cost		30-year Present Value of Contributions		30-year Ending Funded Ratio (MVA / AL)	
	Expected ¹	Downside ²	Expected ¹	Downside ²	Expected ¹	Downside ³
Current Policy (80% R-S)	\$1,509.9	\$2,469.3	\$1,790.3	\$2,407.8	136%	52%
Current Frontier of Results						
0% Return-Seeking	\$2,466.1	\$2,707.4	\$2,192.4	\$2,361.4	55%	41%
10% Return-Seeking	\$2,356.5	\$2,639.5	\$2,115.2	\$2,335.6	59%	43%
20% Return-Seeking	\$2,244.3	\$2,592.5	\$2,042.4	\$2,329.8	63%	45%
30% Return-Seeking	\$2,127.9	\$2,557.2	\$1,974.2	\$2,330.4	68%	46%
40% Return-Seeking	\$2,004.3	\$2,530.5	\$1,916.1	\$2,344.9	75%	47%
50% Return-Seeking	\$1,882.1	\$2,509.0	\$1,871.9	\$2,355.1	85%	48%
60% Return-Seeking	\$1,754.4	\$2,488.8	\$1,834.4	\$2,375.1	99%	50%
70% Return-Seeking	\$1,625.8	\$2,474.3	\$1,808.2	\$2,392.0	116%	51%
80% Return-Seeking	\$1,509.9	\$2,469.3	\$1,790.3	\$2,407.8	136%	52%
90% Return-Seeking	\$1,401.1	\$2,470.6	\$1,777.5	\$2,425.3	160%	52%
100% Return-Seeking	\$1,316.6	\$2,482.6	\$1,767.4	\$2,448.3	185%	53%

Key Findings:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period at allocations above ~60% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

¹ Expected = 50th percentile outcome or central expectation across all 5,000 simulations

² Downside = 95th percentile outcome across all 5,000 simulations

³ Downside = 5th percentile outcome across all 5,000 simulations



Additional Analysis

- County Cash Balance Plan

County Cash Balance Plan

Current State Asset-Liability Profile As of January 1, 2021

Asset-Liability Snapshot as of 1/1/2021		
Metric (\$, Millions)	Value	Fund %
Market Value of Assets	\$655.4	109.3%
Actuarial Value of Assets	\$615.8	102.7%
Liability Metrics		
Actuarial Liability (AL) - Funding	\$599.4 ¹	

Asset-Liability Growth Metrics			
Metric (\$, Millions)	Value	% Liability	% Assets
AL Discount Cost	\$43.8	7.30%	6.68%
AL Normal Cost	\$27.8	4.64%	4.24%
Total Liability Hurdle Rate	\$71.6	11.94%	10.92%
Expected Return on Assets ²	\$41.4	6.90%	6.31%
Total Contributions	\$34.7	5.80%	5.30%
Total Exp. Asset Growth	\$76.1	12.70%	11.61%
Hurdle Rate Shortfall/(Surplus)	-\$4.5	-0.76%	-0.69%
Est. Benefit Payments	\$43.7	7.30%	6.67%

¹ Based on a 7.30% discount rate consistent with the January 1, 2021 valuation results.

² Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions.

Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

Percentages may not sum to 100% due to rounding.

Key Takeaways:

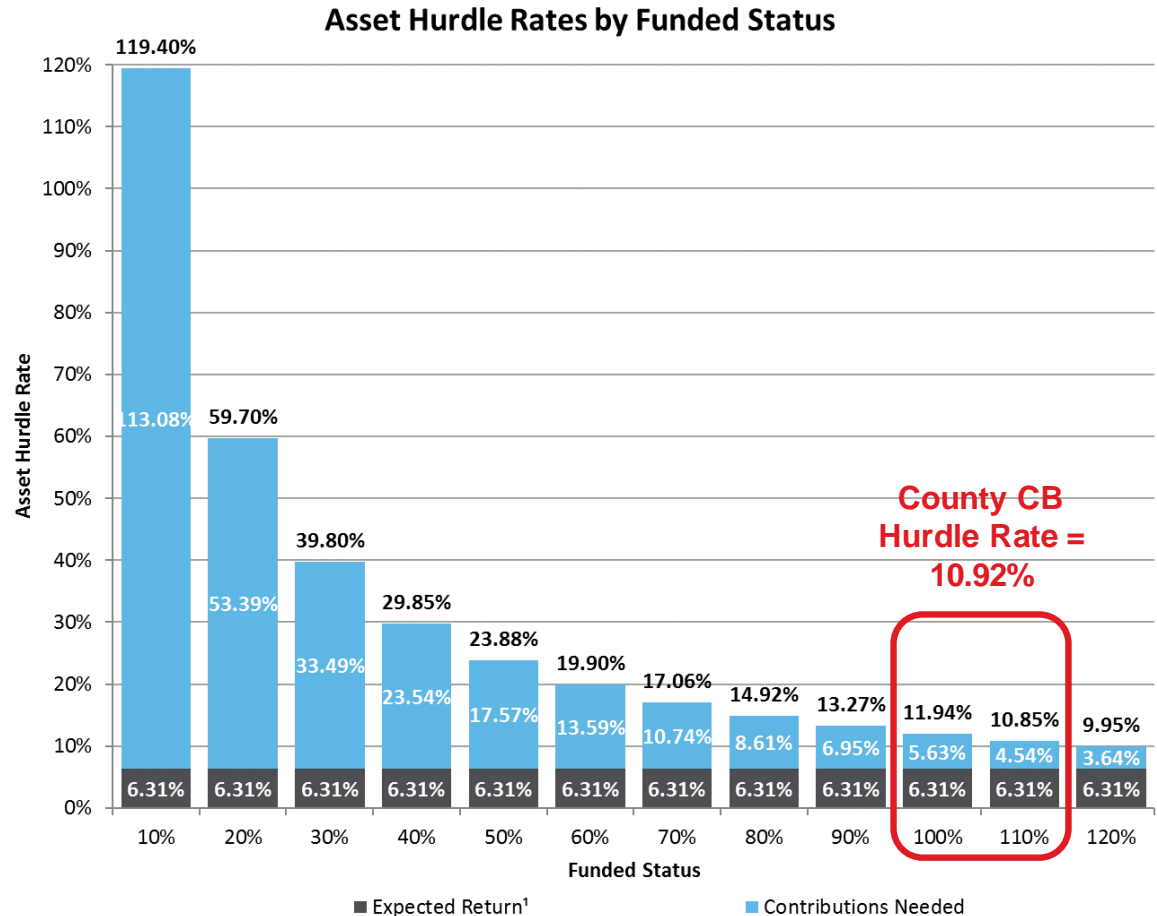
- Pension plan is 109.3% funded on a market value of assets basis as of January 1, 2021
- Asset allocation is 80% return-seeking assets with 20% risk-reducing/safety assets to withstand stressed markets
- Asset hurdle rate of 10.92%, via cash funding and investment returns, needed to maintain or improve actuarial funded status

Target Asset Allocation as of 1/1/2021		
Metric (\$, Millions)	Value	Alloc %
Return-Seeking		
- U.S. Equity	\$177.0	27%
- International Equity	\$75.4	12%
- Global Equity	\$124.5	19%
- Private Equity	\$32.8	5%
- Real Estate	\$49.2	8%
- Non-Core Bonds	\$65.5	10%
- Total	\$524.3	80%
Risk-Reducing		
- Core Bonds	\$131.1	20%
- Total	\$131.1	20%
Total	\$655.4	100%

County Cash Balance Plan

Asset Hurdle Rate

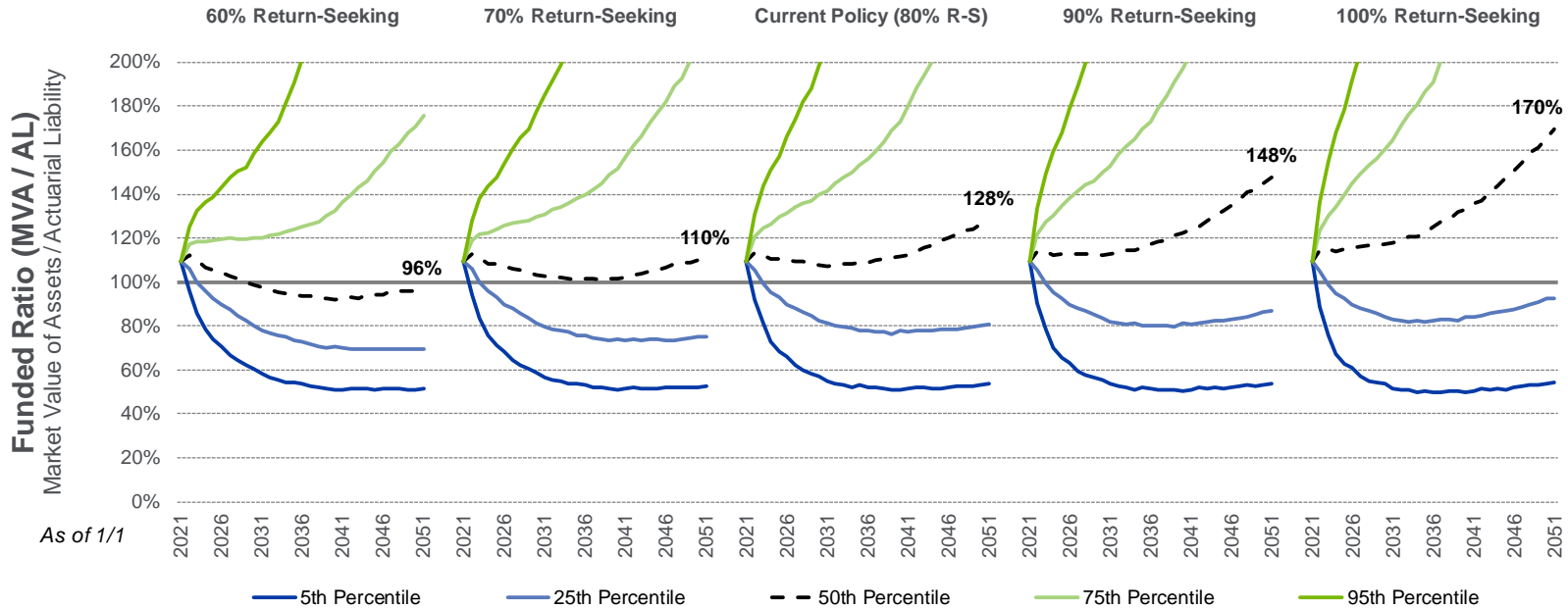
- **Asset Hurdle Rate** is the level of asset growth needed to keep pace with the growth of the Plan liabilities
 - Assets must grow at this rate or more in order to maintain or increase the existing funding surplus
- Assets can grow via:
 - Investment performance, and/or
 - Funding contributions
- Asset hurdle rates increase as funded ratio declines, as shown in the chart to the right



Expected returns are using Aon Investments' Q3 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix.

County Cash Balance Plan

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2031	2041	2051	2031	2041	2051	2031	2041	2051	2031	2041	2051	2031	2041	2051
5th Percentile	58%	51%	51%	57%	51%	52%	55%	51%	53%	53%	51%	54%	51%	50%	54%
25th Percentile	78%	70%	70%	80%	74%	75%	81%	77%	81%	82%	81%	87%	83%	84%	93%
50th Percentile	97%	92%	96%	102%	102%	110%	107%	112%	128%	113%	124%	148%	118%	136%	170%
75th Percentile	120%	136%	176%	131%	157%	>200%	142%	180%	>200%	153%	>200%	>200%	164%	>200%	>200%
95th Percentile	164%	>200%	>200%	185%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%	>200%

Key Takeaways:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 70% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

County Cash Balance Plan

Funded Ratio Analysis (Based on Market Value of Assets)

The **County Cash Balance Plan** is projected to have the following probability of exceeding key funded ratio thresholds under the Current portfolio mix:

Funded Status	After 5 Years					After 10 Years					After 30 Years				
	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S	60% R-S	70% R-S	Current Policy (80% R-S)	90% R-S	100% R-S
100%	57.9%	60.8%	63.0%	64.9%	65.9%	46.6%	52.8%	57.4%	60.3%	62.4%	47.6%	55.2%	62.1%	67.4%	71.8%
90%	74.3%	74.7%	74.8%	74.9%	74.9%	60.0%	64.1%	67.0%	69.0%	70.0%	54.4%	61.7%	68.3%	73.2%	76.5%
80%	87.3%	86.0%	85.1%	84.1%	83.4%	73.1%	74.6%	75.9%	76.6%	76.8%	63.7%	70.3%	75.6%	79.3%	82.1%
70%	95.4%	94.1%	92.8%	91.5%	90.4%	85.2%	85.0%	84.8%	84.7%	84.4%	74.4%	79.9%	83.4%	85.8%	87.2%
60%	98.8%	98.0%	97.0%	96.1%	95.2%	93.8%	93.1%	92.4%	91.5%	90.8%	86.6%	89.3%	90.8%	92.1%	92.8%
50%	99.9%	99.6%	99.2%	98.6%	98.0%	98.6%	98.1%	97.3%	96.5%	95.7%	95.8%	96.2%	96.4%	96.5%	96.5%
40%	100.0%	100.0%	99.9%	99.7%	99.4%	99.9%	99.7%	99.4%	99.1%	98.8%	99.6%	99.5%	99.5%	99.4%	99.1%
30%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.8%	100.0%	100.0%	100.0%	99.9%	99.9%
20%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
10%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

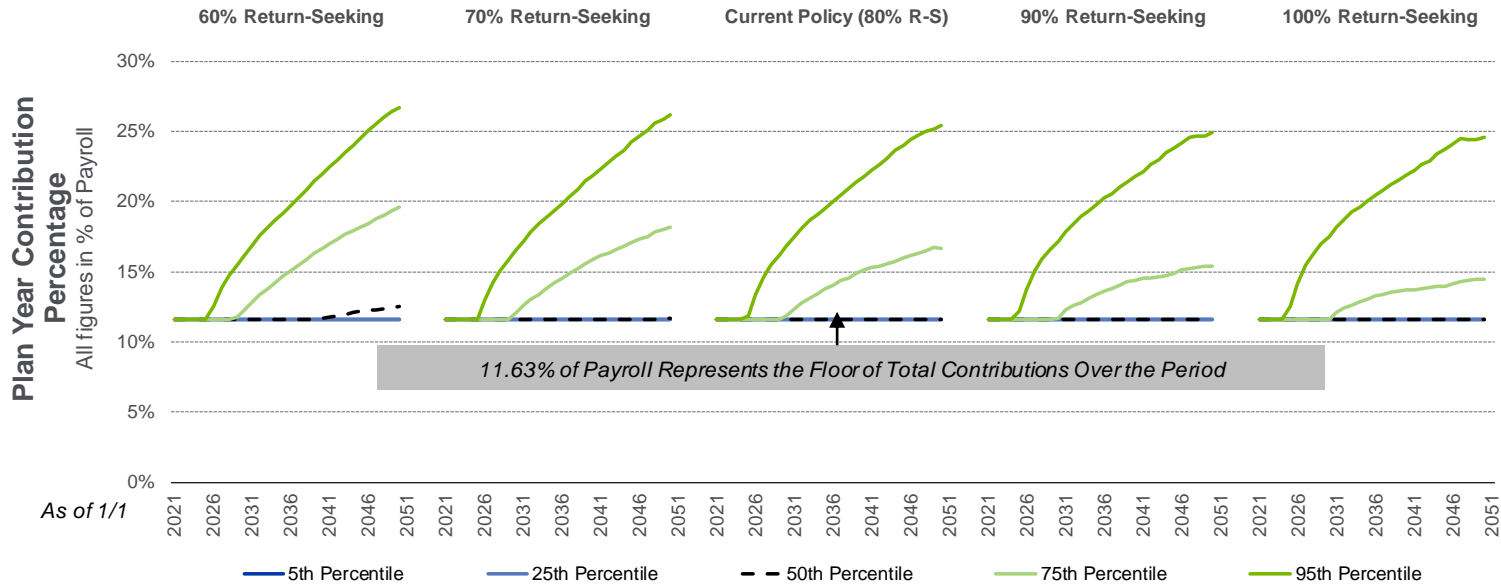
Key Takeaway:

- Higher risk portfolios are projected to have more upside potential over longer periods of time while lower risk portfolios are expected to have higher downside protection in the near-term

Blue = Greater than 50% chance of surpassing a given threshold

County Cash Balance Plan

Total Contribution Percentage of Payroll



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
25th Percentile	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
50th Percentile	12%	12%	13%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
75th Percentile	12%	17%	20%	12%	16%	18%	12%	15%	17%	12%	14%	15%	12%	14%	14%
95th Percentile	16%	22%	27%	16%	22%	26%	17%	22%	25%	17%	22%	25%	18%	22%	25%

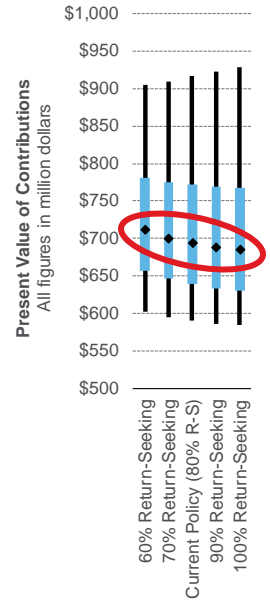
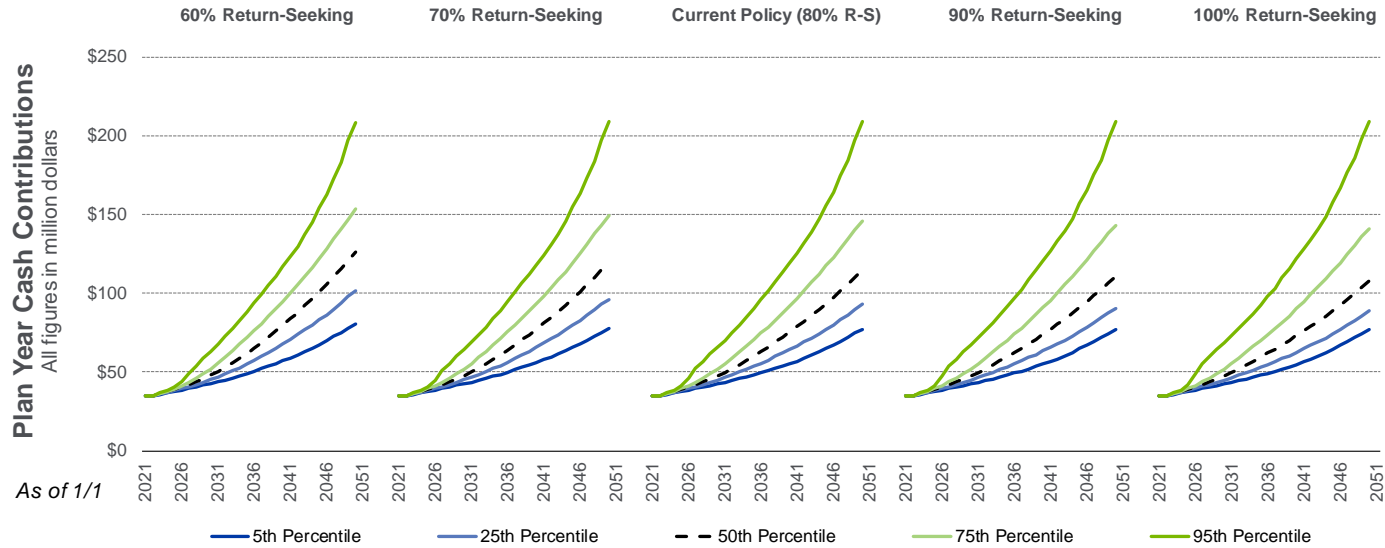
Key Takeaways:

- Total contribution percentages (Employee + Employer) are not expected to be above the statutory amount (11.63%) in our central expectation (50th percentile outcomes) across investment strategies
- Statutory amounts being greater than the actuarially-determined amount is advancing funding into the Plan

* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

County Cash Balance Plan

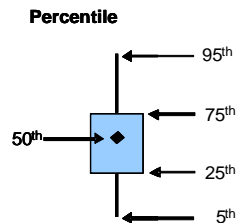
Total Contribution Amount



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	\$43	\$57	\$81	\$43	\$56	\$78	\$42	\$55	\$77	\$42	\$55	\$77	\$42	\$55	\$77
25th Percentile	\$45	\$68	\$102	\$45	\$66	\$96	\$45	\$64	\$93	\$45	\$63	\$90	\$45	\$62	\$89
50th Percentile	\$48	\$80	\$126	\$48	\$77	\$120	\$48	\$75	\$115	\$48	\$74	\$111	\$48	\$73	\$108
75th Percentile	\$52	\$95	\$153	\$52	\$93	\$150	\$52	\$92	\$146	\$52	\$91	\$143	\$52	\$90	\$141
95th Percentile	\$63	\$117	\$209	\$64	\$118	\$209	\$66	\$119	\$209	\$67	\$121	\$209	\$69	\$122	\$209

Key Takeaways:

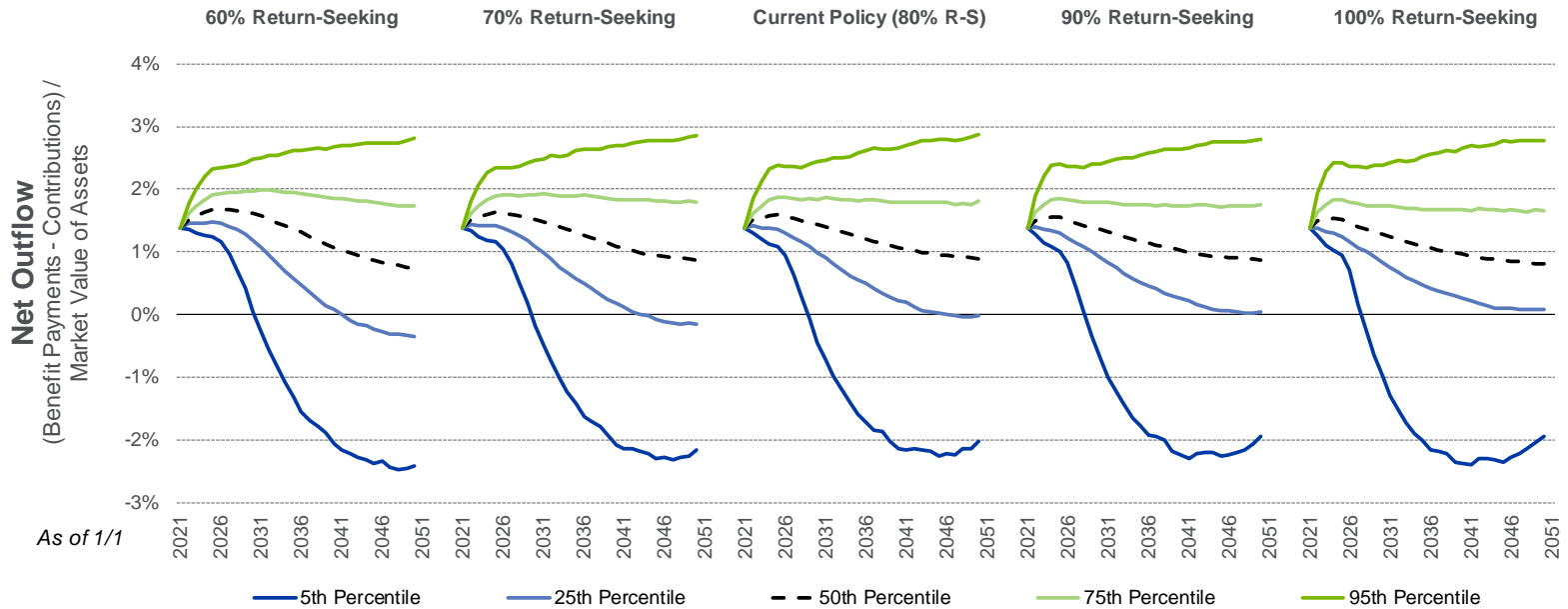
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County Cash Balance Plan

Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



Strategy	60% Return-Seeking			70% Return-Seeking			Current Policy (80% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
5th Percentile	0.0%	-2.1%	-2.4%	-0.2%	-2.1%	-2.2%	-0.5%	-2.1%	-2.0%	-0.7%	-2.2%	-1.9%	-1.0%	-2.4%	-1.9%
25th Percentile	1.2%	0.1%	-0.3%	1.1%	0.2%	-0.1%	1.0%	0.2%	0.0%	0.9%	0.3%	0.0%	0.8%	0.3%	0.1%
50th Percentile	1.6%	1.1%	0.8%	1.5%	1.1%	0.9%	1.4%	1.1%	0.9%	1.4%	1.0%	0.9%	1.3%	1.0%	0.8%
75th Percentile	2.0%	1.9%	1.7%	1.9%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.7%	1.8%	1.7%	1.7%	1.7%
95th Percentile	2.5%	2.7%	2.8%	2.5%	2.7%	2.9%	2.4%	2.7%	2.9%	2.4%	2.6%	2.8%	2.4%	2.7%	2.8%
Probability > 10%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Key Takeaway:

- Net outflow is consistent across the policies modeled with central expectations (50th percentile outcome) in the 0-2% range

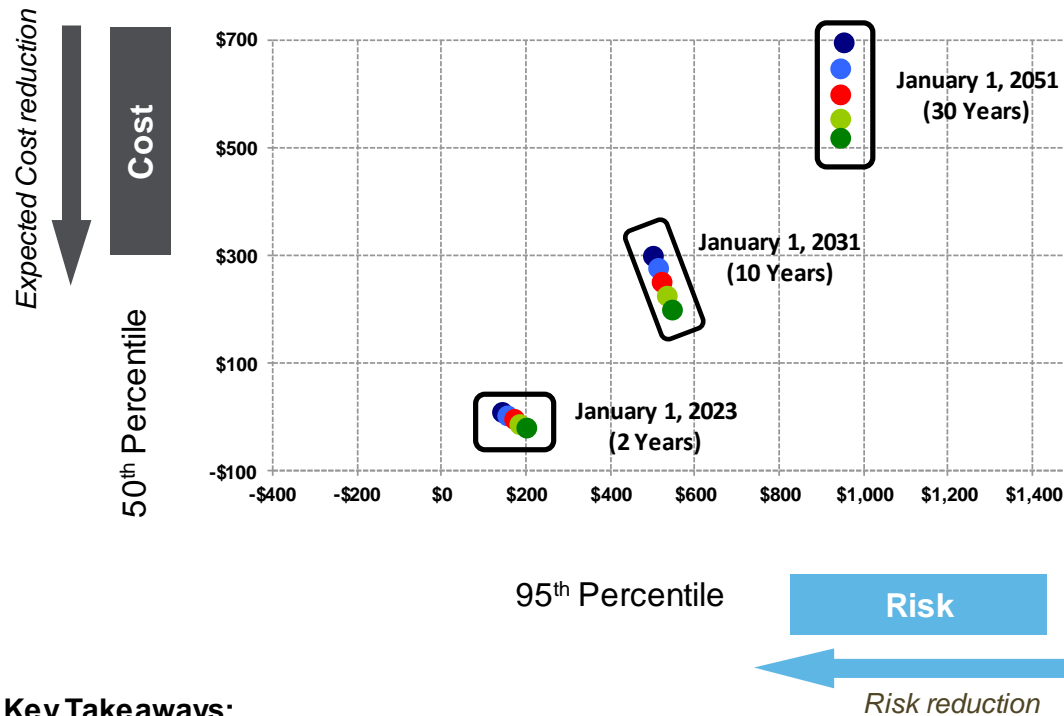
* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied

County Cash Balance Plan

Economic Cost Analysis—2-Year, 10-Year, and 30-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 7.00%, \$millions



Economic Cost		
January 1, 2023		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$8.4	\$145.5
70% Return-Seeking	\$0.6	\$159.6
Current Policy (80% R-S)	(\$6.7)	\$174.2
90% Return-Seeking	(\$13.7)	\$189.4
100% Return-Seeking	(\$20.5)	\$204.1
January 1, 2031		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$297.5	\$504.9
70% Return-Seeking	\$273.5	\$514.5
Current Policy (80% R-S)	\$247.8	\$525.6
90% Return-Seeking	\$223.8	\$537.8
100% Return-Seeking	\$198.3	\$549.8
January 1, 2051		
Strategy (\$Millions)	Cost	Risk
60% Return-Seeking	\$690.9	\$954.1
70% Return-Seeking	\$643.3	\$949.4
Current Policy (80% R-S)	\$595.5	\$947.3
90% Return-Seeking	\$552.2	\$946.8
100% Return-Seeking	\$514.8	\$946.5

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- Under the Current Policy over a 30-year time horizon, the expected Economic Cost is \$595.5M and the potential risk is \$947.3M

* Liability projections assume discount rates of 7.30% (2021), 7.20% (2022), 7.10% (2023), and 7.00% (2024+) for all investment policies studied; Reflects a utility function: Excludes 50% of surplus in excess of 140% of Actuarial liability, and includes twice the shortfall below 40% of Actuarial liability, on a market value basis

County Cash Balance Plan

Summary and Conclusions

All Scenarios \$ Millions	30-year Economic Cost		30-year Present Value of Contributions		30-year Ending Funded Ratio (MVA / AL)	
	Expected ¹	Downside ²	Expected ¹	Downside ²	Expected ¹	Downside ³
Current Policy (80% R-S)	\$595.5	\$947.3	\$694.1	\$916.3	128%	53%
Current Frontier of Results						
0% Return-Seeking	\$949.2	\$1,040.6	\$842.3	\$903.6	57%	43%
10% Return-Seeking	\$910.6	\$1,015.5	\$814.9	\$894.8	61%	46%
20% Return-Seeking	\$870.0	\$997.0	\$789.2	\$891.3	65%	47%
30% Return-Seeking	\$827.6	\$983.1	\$765.1	\$891.3	70%	48%
40% Return-Seeking	\$782.8	\$971.3	\$743.5	\$894.3	76%	49%
50% Return-Seeking	\$737.8	\$964.0	\$726.9	\$899.4	84%	50%
60% Return-Seeking	\$690.9	\$954.1	\$712.4	\$904.4	96%	51%
70% Return-Seeking	\$643.3	\$949.4	\$701.1	\$909.5	110%	52%
80% Return-Seeking	\$595.5	\$947.3	\$694.1	\$916.3	128%	53%
90% Return-Seeking	\$552.2	\$946.8	\$689.3	\$922.6	148%	54%
100% Return-Seeking	\$514.8	\$946.5	\$685.1	\$928.7	170%	54%

Key Findings:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period for allocations at or above 70% return-seeking assets
- Higher (or lower) return-seeking strategies adjust the central trend lines

¹ Expected = 50th percentile outcome or central expectation across all 5,000 simulations

² Downside = 95th percentile outcome across all 5,000 simulations

³ Downside = 5th percentile outcome across all 5,000 simulations



Additional Analysis

- Liquidity Analysis (School Retirement System)

Overview

Background

- NPERS's liquidity analysis is performed under the Current Policy (outlined on the next slide)
 - Intended as a stress-testing model, incorporating the profile of the liabilities as well as expected future contributions
 - Uses different scenarios for economic environments and other relevant events
 - Shows how the portfolio's liquidity profile could evolve with a given investment strategy
- We categorized investments by liquidity into five buckets
 - **Liquid (Risk-Reducing Assets):** less than 3 months needed for return of capital (e.g., publicly traded securities)
 - **Liquid (Return-Seeking Assets):** less than 3 months needed for return of capital (e.g., publicly traded securities)
 - **Quasi-Liquid:** Typical lock-up of 3–12 months. Conservatively, we assumed a 1-year lock-up in most economic environments, 2 years in a Recession scenario, and 3 years in a Black Skies scenario (e.g., many hedge funds, core real estate)
 - **Illiquid: Potential lock-up of 5–10 years,** depending on economic environment (e.g., closed-ended real estate)
 - **Illiquid: Potential lock-up of 10+ years** (e.g., typical private equity)
- This is intended to be a conservative approximation of the actual liquidity properties of the assets
- Not surprisingly, varying economic and contribution scenarios would lead NPERS's percentage allocation to alternative assets to differ from its targets due to liquidity differences in asset classes
- Additional information on the liquidity analysis can be found in the Appendix

Overview

Asset Allocation and Liquidity Category

Asset Class		Target Asset Allocation				
		Liquid	Quasi-Liquid	Illiquid 5-10 Years	Illiquid 10+ Years	Total
Return-Seeking	Public Equities	57.5%				57.5%
	Real Estate		5.6%	1.9%		7.5%
	Private Equity				5.0%	5.0%
	Non-Core Bonds	10.0%				10.0%
Subtotal		67.5%	5.6%	1.9%	5.0%	80.0%
Risk-Reducing / Safety	U.S. Core Fixed Income	20.0%				20.0%
	Subtotal	20.0%	0.0%	0.0%	0.0%	20.0%
Total		87.5%	5.6%	1.9%	5.0%	100.0%

12.5% Illiquids

Overview

Economic Scenarios

- **Base Case Scenario**

- Markets perform consistent with our Capital Market Assumptions (~50th percentile)

- **Recession Scenario**

- Somewhat pessimistic outlook for the markets (~95th percentile)
- Return-seeking assets decline in the first two years with a modest rebound in later years

- **Dark Skies Scenario**

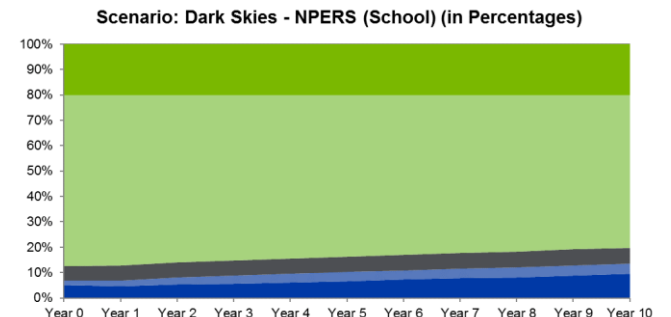
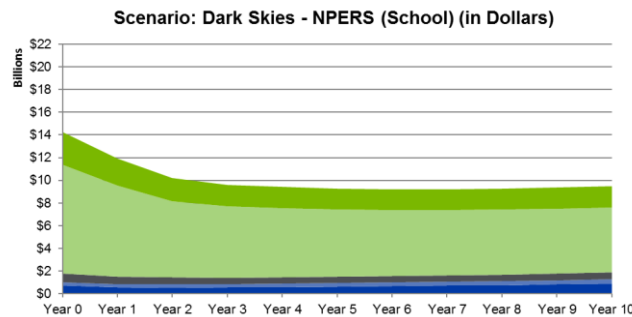
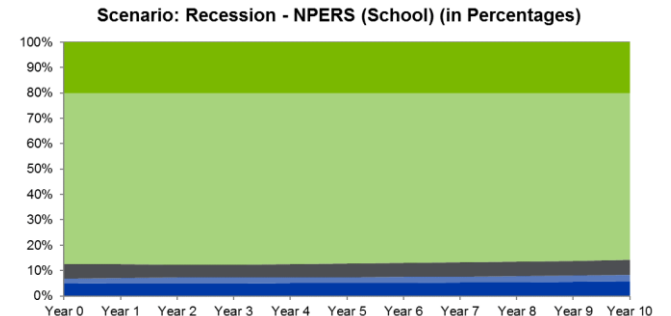
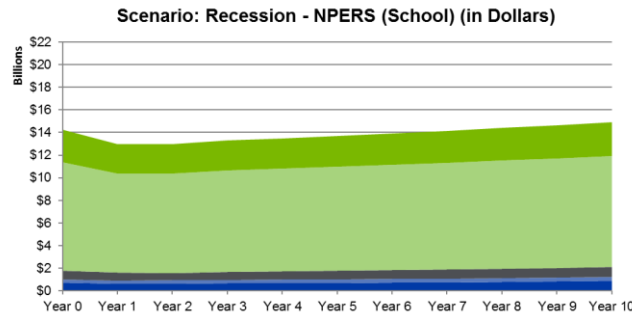
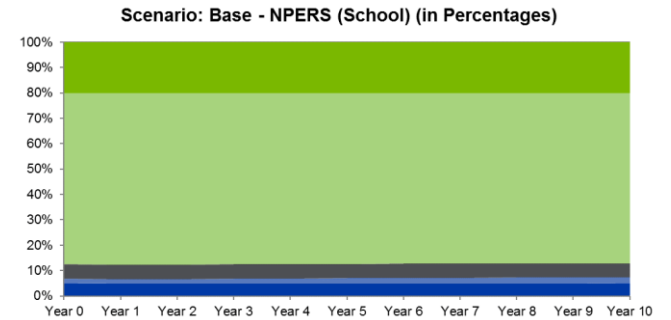
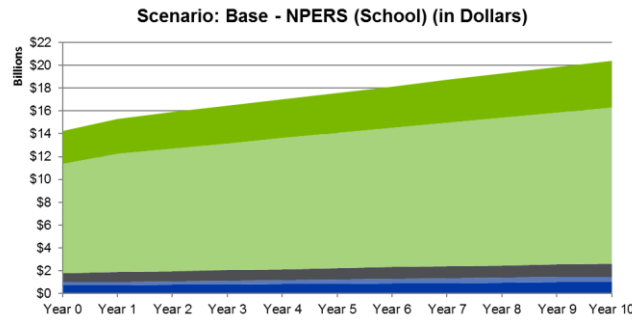
- Very pessimistic outlook for markets (~99th percentile)
- Return-seeking assets decline significantly
- The value of public equities declines approximately 50% over three years, without an immediate rebound

Liquidity Analysis

Summary of Results | Current Policy



■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid (Return-Seeking Assets) ■ Liquid (Risk-Reducing Assets)



Note: Year 0 represents a starting point of March 31, 2021

Conclusions

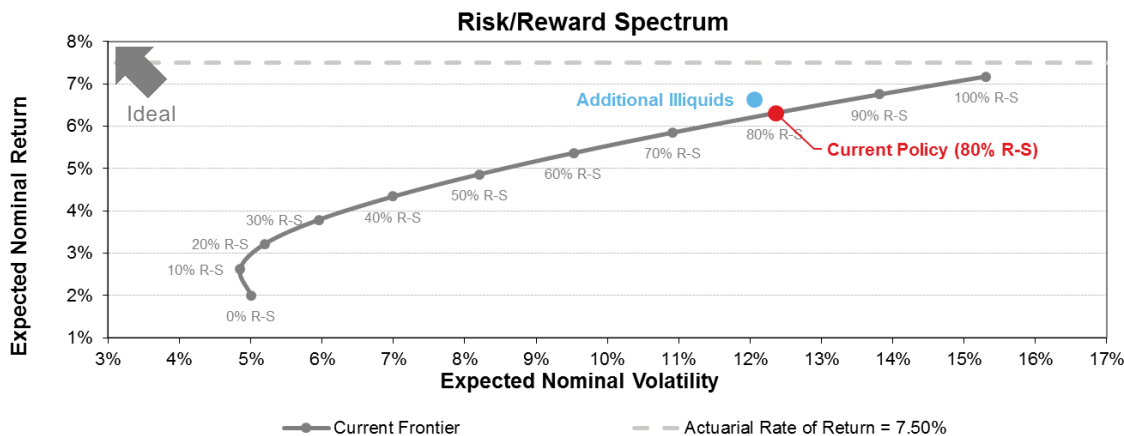
- **The School Retirement System has sufficient liquidity in the modeled Base Case, Recession, and Dark Skies scenarios**
 - The total illiquid and quasi-liquid assets can be maintained near the target allocation with no cash flow problems
 - In pessimistic scenarios, the allocation could drift enough from the target allocation that NPERS may want to rebalance
- This analysis is highly sensitive to the assumed contributions
 - If NPERS receives less contributions than assumed, especially in a Dark Skies environment, then illiquid and quasi-liquid investments drift even further from target and the potential for liquidity issues increases



Additional Analysis

- Portfolio Analysis | Impact of Additional Illiquid Assets

Portfolio Analysis | Risk/Reward Spectrum



Key Takeaway:

- Additional diversification with illiquid assets such as private equity, liquid alternatives, private debt, and infrastructure is expected to improve the risk/return characteristics of the Plan

				Return-Seeking Assets							Risk-Reducing / Safety Assets
	Expected Nominal Return	Expected Nominal Volatility	Sharpe Ratio	Public Equity	Private Equity	Liquid Alts	Non-Core Bonds	Private Debt	Real Estate	Infra	Core Bonds
Current Policy (80% R-S)	6.31%	12.35%	0.422	57.5%	5.0%	0.0%	10.0%	0.0%	7.5%	0.0%	20.0%
Additional Illiquids	6.64%	12.05%	0.459	45.0%	10.0%	10.0%	2.5%	2.5%	7.5%	2.5%	20.0%
Current Frontier											
0% Return-Seeking	2.00%	5.00%	0.180	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
10% Return-Seeking	2.62%	4.85%	0.314	7.2%	0.6%	0.0%	1.3%	0.0%	0.9%	0.0%	90.0%
20% Return-Seeking	3.22%	5.20%	0.407	14.4%	1.3%	0.0%	2.5%	0.0%	1.9%	0.0%	80.0%
30% Return-Seeking	3.79%	5.96%	0.451	21.6%	1.9%	0.0%	3.8%	0.0%	2.8%	0.0%	70.0%
40% Return-Seeking	4.34%	6.99%	0.463	28.8%	2.5%	0.0%	5.0%	0.0%	3.8%	0.0%	60.0%
50% Return-Seeking	4.86%	8.21%	0.459	35.9%	3.1%	0.0%	6.3%	0.0%	4.7%	0.0%	50.0%
60% Return-Seeking	5.37%	9.53%	0.448	43.1%	3.8%	0.0%	7.5%	0.0%	5.6%	0.0%	40.0%
70% Return-Seeking	5.85%	10.92%	0.435	50.3%	4.4%	0.0%	8.8%	0.0%	6.6%	0.0%	30.0%
80% Return-Seeking	6.31%	12.35%	0.422	57.5%	5.0%	0.0%	10.0%	0.0%	7.5%	0.0%	20.0%
90% Return-Seeking	6.75%	13.82%	0.409	64.7%	5.6%	0.0%	11.3%	0.0%	8.4%	0.0%	10.0%
100% Return-Seeking	7.18%	15.31%	0.397	71.9%	6.3%	0.0%	12.5%	0.0%	9.4%	0.0%	0.0%

Expected returns are based on historical performance of the underlying assets. Assumptions do not include fees and expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are made in good faith and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in the Appendix. Percentages may not sum to 100% due to rounding.



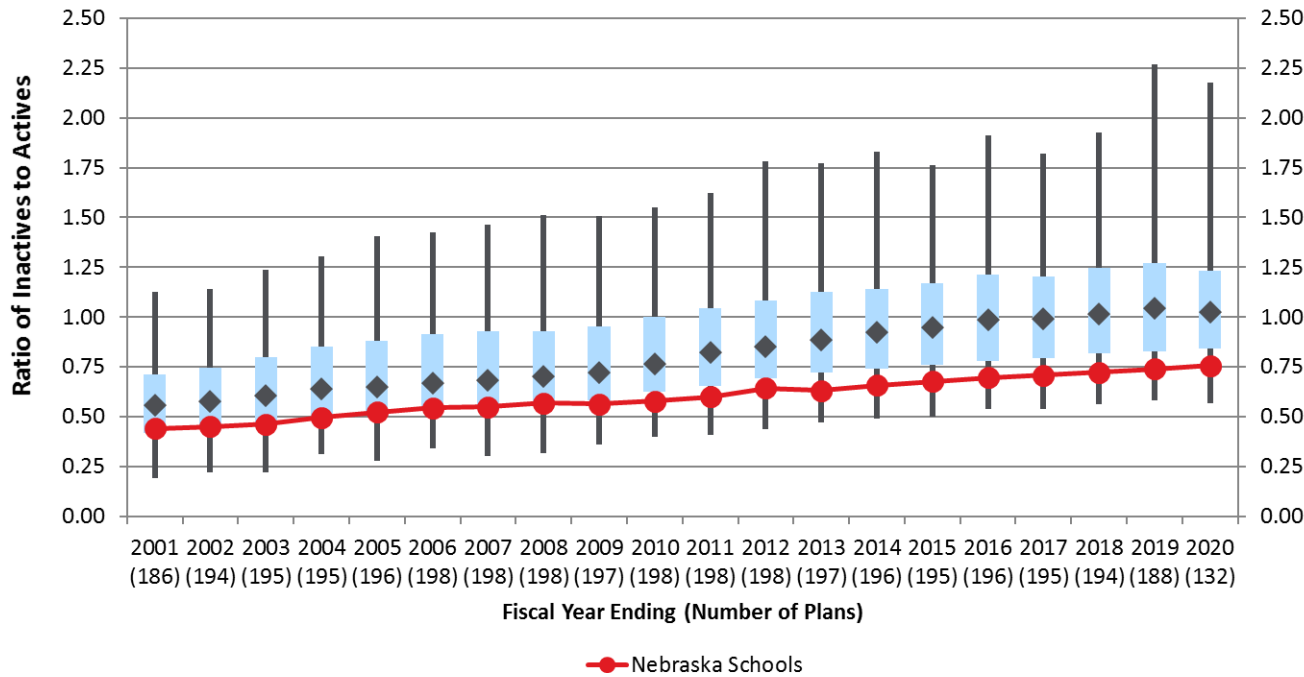
Additional Analysis

- Peer Comparisons

Peer Comparisons

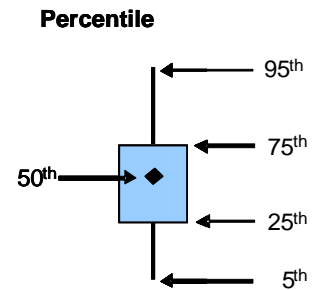
Demographic Data versus Peers¹

Support Ratio Distribution Amongst U.S. Public Pension Plans



Key Takeaways:

- “Support Ratio” defined as the ratio of inactive participants to active participants
- The Schools’ support ratio as of FYE 2020 was 0.76



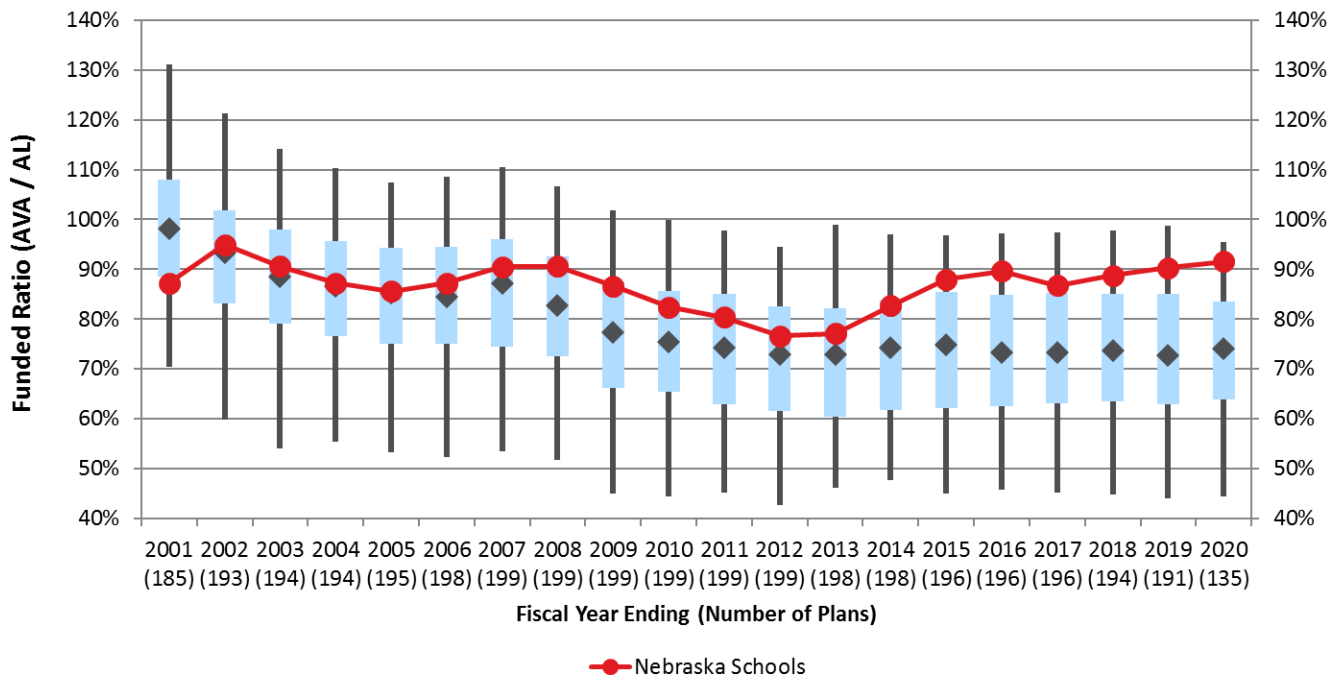
Sources: Public PlansData (publicplansdata.org) as of April 2021;

¹ Peers defined as public funds published within publicplansdata.org as of April 2021; Number of plans per year are shown in parentheses

Peer Comparisons

Funded Ratio (Based on Actuarial Value of Assets) versus Peers¹

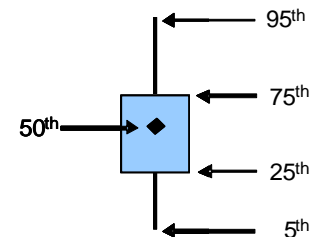
Distribution of U.S. Public Pension Funded Ratios



Key Takeaways:

- The median funded ratio as of FYE 2020 was 74% based on the latest survey data
- The Schools' FYE 2020 funded ratio (92%) lied between the 5th and 25th percentile relative to its peers

Percentile



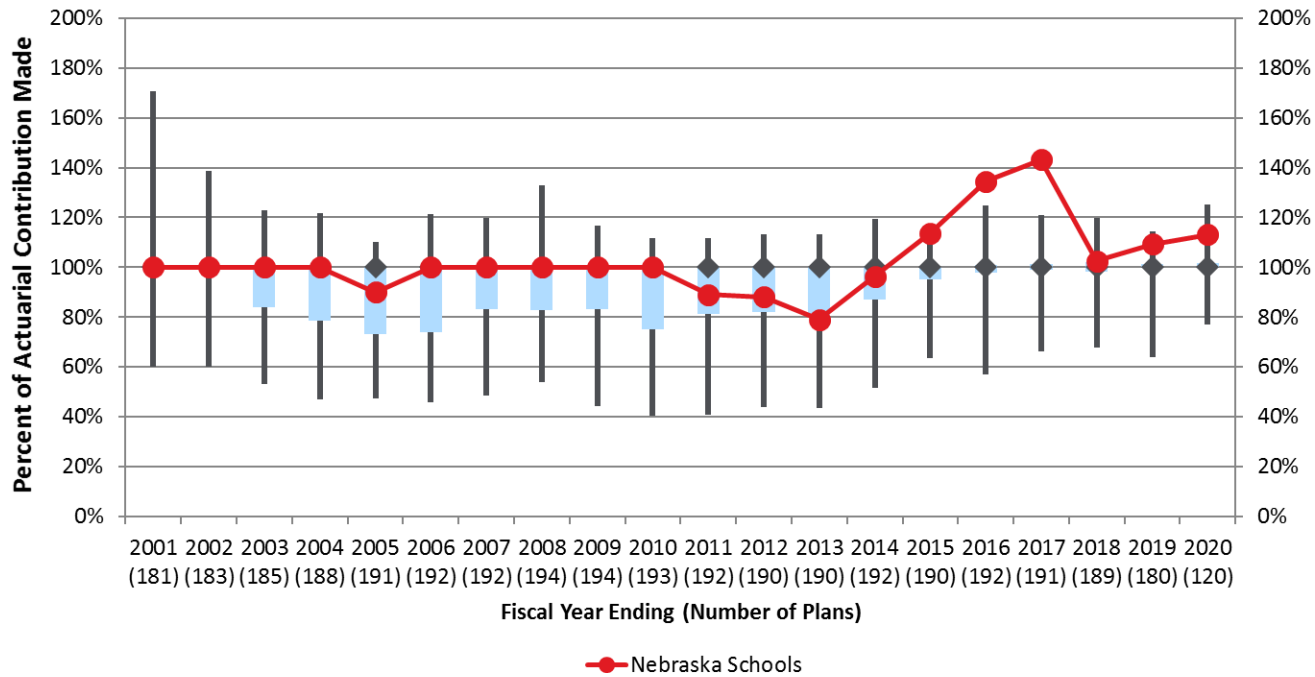
Source: Public PlansData (publicplansdata.org) as of April 2021;

¹ Peers defined as public funds published within publicplansdata.org as of April 2021; Number of plans per year are shown in parentheses

Peer Comparisons

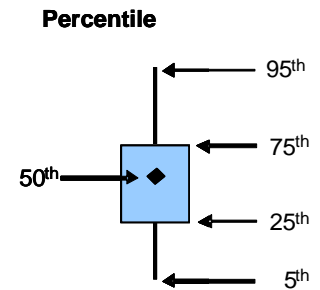
Employer Contributions versus Peers¹

Distribution of U.S. Public Pension % of Actuarial Contribution



Key Takeaway:

- Over the last few fiscal years, the Schools have made contributions greater than the full actuarial contribution



Source: Public PlansData (publicplansdata.org) as of April 2021;
¹ Peers defined as public funds published within publicplansdata.org as of April 2021; Number of plans per year are shown in parentheses



Appendix

- Actuarial Assumptions and Methods

Actuarial Assumptions and Methods

- Actuarial projections provided by the plan actuary as of July 1, 2020
- Actuarial assumptions:
 - Valuation Rate of Interest = 7.50% for 2020, 7.30% for 2021, 7.20% for 2022, 7.10% for 2023, and 7.00% for 2024+
 - Inflation = 2.75% for 2020, 2.65% for 2021, 2.55% for 2022, 2.45% for 2023, and 2.35% for 2024+
 - Salary Scale = assumed to increase 3.50% per year
 - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 5 years
 - All other assumptions as documented in the July 1, 2020 actuarial valuation reports
- Actuarially Determined Contribution Calculation = Normal Cost plus a level percent amortization of the unfunded liability with layered 30 year, closed periods
- Contributions:
 - Member = 9.78% (Schools), 16.00% (State Patrol), or 8.35%-10.00% (Judges) of annual compensation
 - Employer = 9.88% (Schools), 16.00% (State Patrol) of the members' contributions
 - State = 2.00% (Schools) of annual compensation
 - Other = \$3M of Court Fees (Judges)
 - Additional contributions that are necessary each year to pay the excess of the normal cost plus an amortization payment to fund unfunded actuarial accrued liability bases, over Member, Employer, State, and Other contributions
- Actual asset performance from July 1, 2020 to March 31, 2021 (+22.33%) was incorporated into the analysis

Actuarial Assumptions and Methods

State Cash Balance Plan and County Cash Balance Plan

- Actuarial projections provided by the plan actuary as of January 1, 2021
- Actuarial assumptions:
 - Valuation Rate of Interest = 7.30% for 2021, 7.20% for 2022, 7.10% for 2023, and 7.00% for 2024+
 - Inflation = 2.65% for 2021, 2.55% for 2022, 2.45% for 2023, and 2.35% for 2024+
 - Interest Crediting Rate = 6.75%
 - Salary Scale = assumed to increase 3.50% per year
 - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 5 years
 - All other assumptions as documented in the January 1, 2020 actuarial valuation reports
- Plan Provisions
 - Interest crediting rate is the greater of (a) 5.00% or (b) the applicable federal mid-term rate plus 1.50%
 - Granting of dividends, contingent upon the financial health of the plan, is voluntary and has therefore not been factored into this analysis
- Actuarially Determined Contribution Calculation = Normal Cost plus a level dollar amortization of the unfunded liability with layered 25 year, closed periods
- Contributions:
 - Member = 4.80% (State) or 4.50% (County¹) of annual compensation
 - Employer = 156% (State) or 150% (County¹) of the members' contributions
 - Additional contributions that are necessary each year to pay the excess of the normal cost plus an amortization payment to fund unfunded actuarial accrued liability bases, over member and employer contributions
- Actual asset performance from January 1, 2021 to March 31, 2021 (+4.14%) was incorporated into the analysis

¹Commissioned law enforcement personnel contribute an additional 1.00-2.00% based on county population and participating counties will match the additional contributions made by commissioned law enforcement personnel



Appendix

- Capital Market Assumptions

Aon Investments' Capital Market Assumptions

As of June 30, 2020 (30 Years)

	Expected Real Return ¹	Expected Nominal Return ¹	Expected Nominal Volatility
Equity			
1 Large Cap U.S. Equity	4.3%	6.5%	17.0%
2 Small Cap U.S. Equity	4.8%	7.0%	23.0%
3 Global Equity IMI	5.2%	7.4%	18.5%
4 International Equity (Developed)	5.3%	7.5%	20.0%
5 Emerging Markets Equity	5.9%	8.1%	27.0%
Fixed Income			
6 Cash (Gov't)	-1.0%	1.1%	2.0%
7 TIPS	-0.1%	2.0%	4.5%
8 Core Fixed Income	-0.1%	2.0%	5.0%
9 Intermediate Gov't Bonds (4-Year Duration)	-0.8%	1.3%	3.5%
10 Intermediate Corporate Bonds (4-Year Duration)	0.2%	2.3%	5.0%
11 Long Duration Bonds – Gov't	-0.5%	1.6%	10.5%
12 Market-Duration (5-Yr) Non-Govt Bonds	0.5%	2.6%	6.5%
13 High Yield Bonds	2.0%	4.1%	12.0%
14 Bank Loans	2.2%	4.3%	7.5%
15 Emerging Market Bonds	1.9%	4.0%	14.0%
16 Emerging Market Bonds (Corporate USD)	1.4%	3.5%	11.5%
17 Emerging Market Bonds (Sov. Local)	1.6%	3.7%	14.5%
18 Multi-Asset Credit ⁴	2.8%	5.0%	9.5%
Alternatives			
19 Hedge Funds Universe ^{2, 4}	1.2%	3.3%	9.5%
20 Hedge Funds Buy List ^{2, 4}	2.4%	4.5%	9.5%
21 Direct Hedge Funds ^{3, 4}	2.5%	4.7%	9.5%
22 Non Core Real Estate	5.5%	7.7%	25.5%
23 Core Real Estate	3.5%	5.7%	15.0%
24 US REITs	4.0%	6.2%	18.5%
25 Commodities	1.4%	3.5%	17.0%
26 Private Equity	7.2%	9.5%	25.0%
27 Infrastructure	6.1%	8.3%	14.5%
28 Private Debt	3.7%	5.9%	17.0%
Inflation			
29 Inflation	0.0%	2.1%	1.5%

Notes

- ¹ Expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees
- ² Represents diversified portfolio of Fund of funds investments (includes additional layer of fees at the FoF level)
- ³ Represents diversified portfolio of Direct hedge fund investments
- ⁴ Alpha incorporated in Expected Nominal Return

Aon Investments' Capital Market Assumptions

As of June 30, 2020

Nominal Correlations		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	Large Cap U.S. Equity	1.00	0.92	0.96	0.78	0.72	0.09	-0.05	0.04	-0.06	0.08	-0.13	0.12	0.59	0.44	0.42	0.40	0.47	0.57	0.67	0.54	0.66	0.47	0.37	0.67	0.34	0.69	0.38	0.37	0.06
2	Small Cap U.S. Equity	0.92	1.00	0.91	0.72	0.67	0.07	-0.05	0.03	-0.06	0.07	-0.12	0.11	0.55	0.41	0.39	0.37	0.42	0.52	0.61	0.49	0.61	0.44	0.35	0.61	0.29	0.65	0.35	0.35	0.05
3	Global Equity IMI	0.96	0.91	1.00	0.90	0.84	0.08	-0.05	0.04	-0.06	0.08	-0.13	0.13	0.65	0.44	0.47	0.45	0.56	0.62	0.65	0.52	0.64	0.49	0.38	0.65	0.40	0.67	0.37	0.38	0.07
4	International Equity (Developed)	0.78	0.72	0.90	1.00	0.75	0.04	-0.04	0.04	-0.06	0.07	-0.11	0.11	0.58	0.38	0.44	0.43	0.59	0.58	0.55	0.45	0.55	0.44	0.34	0.54	0.45	0.56	0.31	0.33	0.07
5	Emerging Markets Equity	0.72	0.67	0.84	0.75	1.00	0.07	-0.04	0.05	-0.05	0.08	-0.12	0.13	0.65	0.36	0.49	0.46	0.54	0.60	0.47	0.38	0.46	0.40	0.31	0.49	0.33	0.53	0.29	0.31	0.07
6	Cash (Gov't)	0.09	0.07	0.08	0.04	0.07	1.00	0.45	0.45	0.61	0.46	0.21	0.34	0.14	0.18	0.17	0.07	0.03	0.14	-0.02	-0.01	-0.02	0.13	0.14	0.08	0.22	0.08	0.11	0.04	0.57
7	TIPS	-0.05	-0.05	-0.05	-0.04	-0.04	0.45	1.00	0.48	0.58	0.44	0.32	0.37	0.09	-0.06	0.13	0.02	-0.02	0.03	-0.11	-0.09	-0.11	0.01	0.02	-0.03	0.17	-0.04	0.01	-0.10	0.40
8	Core Fixed Income	0.04	0.03	0.04	0.04	0.05	0.45	0.48	1.00	0.86	0.95	0.73	0.94	0.34	0.14	0.52	0.20	0.16	0.30	0.07	0.06	0.07	0.06	0.06	0.04	0.07	0.04	0.06	0.07	0.15
9	Intermediate Gov't Bonds (4-Year Duration)	-0.06	-0.06	-0.06	-0.06	-0.05	0.61	0.58	0.86	1.00	0.75	0.75	0.65	0.05	-0.23	0.23	0.02	0.00	-0.02	-0.22	-0.17	-0.22	0.02	0.04	-0.03	0.10	-0.05	0.02	-0.27	0.26
10	Intermediate Corporate Bonds (4-Year Duration)	0.08	0.07	0.08	0.07	0.08	0.46	0.44	0.95	0.75	1.00	0.56	0.96	0.39	0.32	0.55	0.25	0.19	0.38	0.18	0.15	0.18	0.08	0.08	0.07	0.09	0.07	0.07	0.21	0.20
11	Long Duration Bonds – Gov't	-0.13	-0.12	-0.13	-0.11	-0.12	0.21	0.32	0.73	0.75	0.56	1.00	0.55	-0.12	-0.36	0.16	-0.08	-0.05	-0.15	-0.24	-0.19	-0.23	-0.05	-0.04	-0.09	-0.04	-0.11	-0.04	-0.34	-0.11
12	Market-Duration (5-Yr) Non-Govt Bonds	0.12	0.11	0.13	0.11	0.13	0.34	0.37	0.94	0.65	0.96	0.55	1.00	0.52	0.42	0.65	0.32	0.25	0.50	0.28	0.23	0.28	0.10	0.09	0.09	0.07	0.10	0.09	0.32	0.11
13	High Yield Bonds	0.59	0.55	0.65	0.58	0.65	0.14	0.09	0.34	0.05	0.39	-0.12	0.52	1.00	0.72	0.75	0.62	0.60	0.91	0.64	0.52	0.64	0.32	0.25	0.40	0.38	0.44	0.25	0.61	0.18
14	Bank Loans	0.44	0.41	0.44	0.38	0.36	0.18	-0.06	0.14	-0.23	0.32	-0.36	0.42	0.72	1.00	0.48	0.55	0.43	0.79	0.71	0.57	0.71	0.24	0.19	0.30	0.16	0.33	0.19	0.84	0.17
15	Emerging Market Bonds	0.42	0.39	0.47	0.44	0.49	0.17	0.13	0.52	0.23	0.55	0.16	0.65	0.75	0.48	1.00	0.69	0.65	0.78	0.54	0.43	0.54	0.23	0.18	0.28	0.24	0.30	0.18	0.40	0.09
16	Emerging Market Bonds (Corporate USD)	0.40	0.37	0.45	0.43	0.46	0.07	0.02	0.20	0.02	0.25	-0.08	0.32	0.62	0.55	0.69	1.00	0.62	0.73	0.56	0.45	0.56	0.20	0.15	0.26	0.26	0.27	0.15	0.47	0.09
17	Emerging Market Bonds (Sov. Local)	0.47	0.42	0.56	0.59	0.54	0.03	-0.02	0.16	0.00	0.19	-0.05	0.25	0.60	0.43	0.65	0.62	1.00	0.74	0.49	0.39	0.48	0.19	0.12	0.30	0.45	0.22	0.13	0.36	0.02
18	Multi-Asset Credit	0.57	0.52	0.62	0.58	0.60	0.14	0.03	0.30	-0.02	0.38	-0.15	0.50	0.91	0.79	0.78	0.73	0.74	1.00	0.70	0.56	0.70	0.29	0.22	0.38	0.36	0.39	0.22	0.67	0.15
19	Hedge Funds Universe	0.67	0.61	0.65	0.55	0.47	-0.02	-0.11	0.07	-0.22	0.18	-0.24	0.28	0.64	0.71	0.54	0.56	0.49	0.70	1.00	0.73	0.99	0.31	0.23	0.44	0.30	0.45	0.25	0.62	0.05
20	Hedge Funds Buy List	0.54	0.49	0.52	0.45	0.38	-0.01	-0.09	0.06	-0.17	0.15	-0.19	0.23	0.52	0.57	0.43	0.45	0.39	0.56	0.73	1.00	0.72	0.25	0.19	0.36	0.24	0.37	0.20	0.50	0.04
21	Direct Hedge Funds	0.66	0.61	0.64	0.55	0.46	-0.02	-0.11	0.07	-0.22	0.18	-0.23	0.28	0.64	0.71	0.54	0.56	0.48	0.70	0.99	0.72	1.00	0.30	0.23	0.43	0.30	0.45	0.25	0.61	0.04
22	Non Core Real Estate	0.47	0.44	0.49	0.44	0.40	0.13	0.01	0.06	0.02	0.08	-0.05	0.10	0.32	0.24	0.23	0.20	0.19	0.29	0.31	0.25	0.30	1.00	0.96	0.49	0.15	0.38	0.21	0.19	0.09
23	Core Real Estate	0.37	0.35	0.38	0.34	0.31	0.14	0.02	0.06	0.04	0.08	-0.04	0.09	0.25	0.19	0.18	0.15	0.12	0.22	0.23	0.19	0.23	0.96	1.00	0.45	0.09	0.31	0.18	0.15	0.09
24	US REITs	0.67	0.61	0.65	0.54	0.49	0.08	-0.03	0.04	-0.03	0.07	-0.09	0.09	0.40	0.30	0.28	0.26	0.30	0.38	0.44	0.36	0.43	0.49	0.45	1.00	0.21	0.48	0.26	0.25	0.05
25	Commodities	0.34	0.29	0.40	0.45	0.33	0.22	0.17	0.07	0.10	0.09	-0.04	0.07	0.38	0.16	0.24	0.26	0.45	0.36	0.30	0.24	0.30	0.15	0.09	0.21	1.00	0.13	0.08	0.11	0.39
26	Private Equity	0.69	0.65	0.67	0.56	0.53	0.08	-0.04	0.04	-0.05	0.07	-0.11	0.10	0.44	0.33	0.30	0.27	0.22	0.39	0.45	0.37	0.45	0.38	0.31	0.48	0.13	1.00	0.32	0.28	0.06
27	Infrastructure	0.38	0.35	0.37	0.31	0.29	0.11	0.01	0.06	0.02	0.07	-0.04	0.09	0.25	0.19	0.18	0.15	0.13	0.22	0.25	0.20	0.25	0.21	0.18	0.26	0.08	0.32	1.00	0.16	0.07
28	Private Debt	0.37	0.35	0.38	0.33	0.31	0.04	-0.10	0.07	-0.27	0.21	-0.34	0.32	0.61	0.84	0.40	0.47	0.36	0.67	0.62	0.50	0.61	0.19	0.15	0.25	0.11	0.28	0.16	1.00	0.08
29	Inflation	0.06	0.05	0.07	0.07	0.07	0.57	0.40	0.15	0.26	0.20	-0.11	0.11	0.18	0.17	0.09	0.09	0.02	0.15	0.05	0.04	0.04	0.09	0.09	0.05	0.39	0.06	0.07	0.08	1.00

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

The following capital market assumptions were developed by Aon's Global Asset Allocation Team and represent the long-term capital market outlook (i.e., 30 years) based on data at the end of the second quarter of 2020. The assumptions were developed using a building block approach, reflecting observable inflation and interest rate information available in the fixed income markets as well as Consensus Economics forecasts. Our long-term assumptions for other asset classes are based on historical results, current market characteristics, and our professional judgment.

Inflation – Expected Level (2.1%)

Based on Consensus Economics long-term estimates and our near-term economic outlook, we expect U.S. consumer price inflation to be approximately 2.1% during the next 30 years.

Real Returns for Asset Classes

Fixed Income

- **Cash (-1.0%)** – Over the long run, we expect the real yield on cash and money market instruments to produce a real return of -1.0% in a moderate to low-inflationary environment.
- **TIPS (-0.1%)** – We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about -0.1%.
- **Core Fixed Income (i.e., Market Duration) (-0.1%)** – We expect intermediate duration Treasuries to produce a real return of about -0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.7%, resulting in a long-term real return of -0.1%.
- **Long Duration Bonds – Government and Credit (0.1%)** – We expect Treasuries with a duration comparable to the Long Government Credit Index to produce a real return of -0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.6%, resulting in an expected real return of 0.1%.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

- **Long Duration Bonds – Credit (0.6%)** – We expect Treasuries with a duration comparable to the Long Credit Index to produce a real return of -0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 1.1%, resulting in an expected real return of 0.6%.
- **Long Duration Bonds – Government (-0.5%)** – We expect Treasuries with a duration of ~12 years to produce a real return of -0.5% during the next 30 years.
- **High Yield Bonds (2.0%)** – We expect intermediate duration Treasuries to produce a real return of about -0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 2.8%, resulting in an expected real return of 2.0%.
- **Bank Loans (2.2%)** – We expect LIBOR to produce a real return of about -0.7%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults) to be 2.9%, resulting in an expected real return of 2.2%.
- **Non-US Developed Bonds: 50% Hedged (-0.4%)** – We forecast real returns for non-US developed market bonds to be -0.4% over a 30-year period after adjusting for a 50% currency hedge. We assume a blend of one-third investment grade corporate bonds and two-thirds government bonds. We also produce assumptions for 0% hedged and 100% hedged non-US developed bonds.
- **Emerging Market Bonds (Sovereign; USD) (1.9%)** – We forecast real returns for emerging market sovereign bonds denominated in US dollars to be 1.9% over a 30-year period.
- **Emerging Market Bonds (Corporate; USD) (1.4%)** – We forecast real returns for emerging market corporate bonds denominated in US dollars to be 1.4% over a 30-year period.
- **Emerging Market Bonds (Sovereign; Local) (1.6%)** – We forecast real returns for emerging market sovereign bonds denominated in local currency to be 1.6% over a 30-year period.
- **Multi Asset Credit (MAC) (2.8%)** – We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 2.1% plus 0.7% from alpha (net of fees) over a 30-year period.
- **Private Debt-Direct Lending (3.7%)** – The base building block is bank loans 2.2% + spread 1.5% (net of management fees and performance incentives). There is 100% leverage included in the assumption with the cost of financing at LIBOR + 1.4%.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

Equities

- **Large Cap U.S. Equity (4.3%)** – This assumption is based on our 30-year outlook for large cap U.S. company dividends and real earnings growth. Adjustments are made for valuations as needed.
- **Small Cap U.S. Equity (4.8%)** – Adding a 0.5% return premium for small cap U.S. equity over large cap U.S. equity results in an expected real return of 4.8%. This return premium is theoretically justified by the higher risk inherent in small cap U.S. equity versus large cap U.S. equity, and is also justified by historical data. In recent years, higher small cap valuations relative large cap equity has reduced the small cap premium.
- **Global Equity (Developed & Emerging Markets) (5.2%)** – We employ a building block process similar to the U.S. equity model using the developed and emerging markets that comprise the MSCI All-Country World Index. Our roll-up model produces an expected real return of 5.2% for global equity.
- **International (Non-U.S.) Equity, Developed Markets (5.3%)** – We employ a building block process similar to the U.S. equity model using the non-U.S. developed equity markets that comprise the MSCI EAFE Index.
- **Emerging Market Stocks (5.9%)** - We employ a building block process similar to the U.S. equity model using the non-U.S. emerging equity markets that comprise the MSCI Emerging Markets Index.
- **Equity Risk Insurance Premium Strategies-High Beta (4.1%)** – We expect real returns from 50% equity + 50% cash beta of 2.0% plus 2.1% insurance risk premium over the next 30 years.

Alternative Asset Classes

- **Hedge Fund-of-Funds Universe (1.2%)** – The generic category “hedge funds” encompasses a wide range of strategies accessed through “fund-of-funds” vehicles. We also assume the *median* manager is selected and also allow for the additional costs associated with Fund-of-Funds management. A top-tier portfolio of funds (hedge fund-of-funds buy-list) could add an additional 1.2% in return at similar volatility based on alpha, lower fees and better risk management.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

- **Hedge Fund-of-Funds Buy List (2.4%)** – The generic category of top-tier “hedge funds” encompasses a wide range of strategies accessed through “fund-of-funds” vehicles. We assume additional costs associated with Funds-of-Funds management. To use this category the funds must be buy rated or we advise on manager selection.
- **Broad Hedge Funds Universe (2.5%)** – Represents a diversified portfolio of direct hedge fund investments. This investment will tend to be less diversified than a typical “fund-of-funds” strategy as there will be fewer underlying managers and will not include the extra layer of fees found in a Fund-of-Funds structure.
- **Broad Hedge Funds Buy List (3.8%)** – Represents a diversified portfolio of top-tier direct hedge fund investments. This investment will tend to be less diversified than a typical “fund-of-funds” strategy as there will be fewer underlying managers and will not include the extra layer of fees found in a Fund-of-Funds structure. To use this category the funds must be buy rated or we advise on manager selection.
- **Core Real Estate (3.5%)** -- Our real return assumption for core real estate is based a gross income of about 3.8%, management fees of roughly 1%, and future capital appreciation near the rate of inflation during the next 30 years. We assume a portfolio of equity real estate holdings that is diversified by property and by geographic region.
- **Non-Core Real Estate (5.5%)** -- Core real estate is levered approximately 100% as the base building block for this assumption. We subtract financing costs for the leverage and 2% management costs. We also assume nominal alpha of 3%. We assume a 50/50 mix of value-add and opportunistic investments.
- **U.S. REITs (4.0%)** – Our real return assumption for U.S. REITs is based on income of about 4.0% and future capital appreciation near the rate of inflation during the next 30 years. REITs are a sub-set of U.S. small/mid cap equity universe.
- **Commodities (1.4%)** – Our commodity assumption is for a diversified portfolio of commodity futures contracts. Commodity futures returns are composed of three parts: spot price appreciation, collateral return, and roll return (positive or negative change implied by the shape of the future curve). We believe that spot prices will converge with CPI over the long run (i.e., 2.1%). Collateral is assumed to be LIBOR cash (-0.7%). Also, we believe the roll effect will be near zero, resulting in a real return of about 1.4% for commodities.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

- **Private Equity (7.2%)** – Our private equity assumption reflects a diversified fund of funds with exposure to buyouts, venture capital, distressed debt, and mezzanine debt.
- **Infrastructure (6.1%)** – Our infrastructure assumption is formulated using a cash flow based approach that projects cash flows (on a diversified portfolio of assets) over a 30-year period. Income and capital growth as well as gearing levels, debt costs and terms, relevant tax and management expenses are all taken into consideration. Our approach produces an expected real return of 6.1% for infrastructure.
- **Equity Risk Insurance Premium Strategies-Low Beta (2.4%)** – We assume real returns from cash of $-1.0\% + 3.4\%$ from alpha.
- **Alternative Risk Premia (ARP) (3.2%)** – Real return target LIBOR -0.7% plus 3.9% alpha (net of fees)

Volatility / Correlation Assumptions

Assumed volatilities are formulated with reference to implied volatilities priced into option contracts of various terms, as well as with regard to historical volatility levels. For asset classes which are not marked to market (for example real estate), we “de-smooth” historical returns before calculating volatilities. Importantly, we consider expected volatility trends in the future – in recent years we assumed the re-emergence of an economic cycle and a loss of confidence in central bankers would lead to an increase in volatility. Correlation assumptions are generally similar to actual historical results; however, we do make adjustments to reflect our forward-looking views as well as current market fundamentals.



Appendix

- Horizon Survey of Capital Market Assumptions

2020 Horizon Survey Results

▪ What is the Horizon Survey?

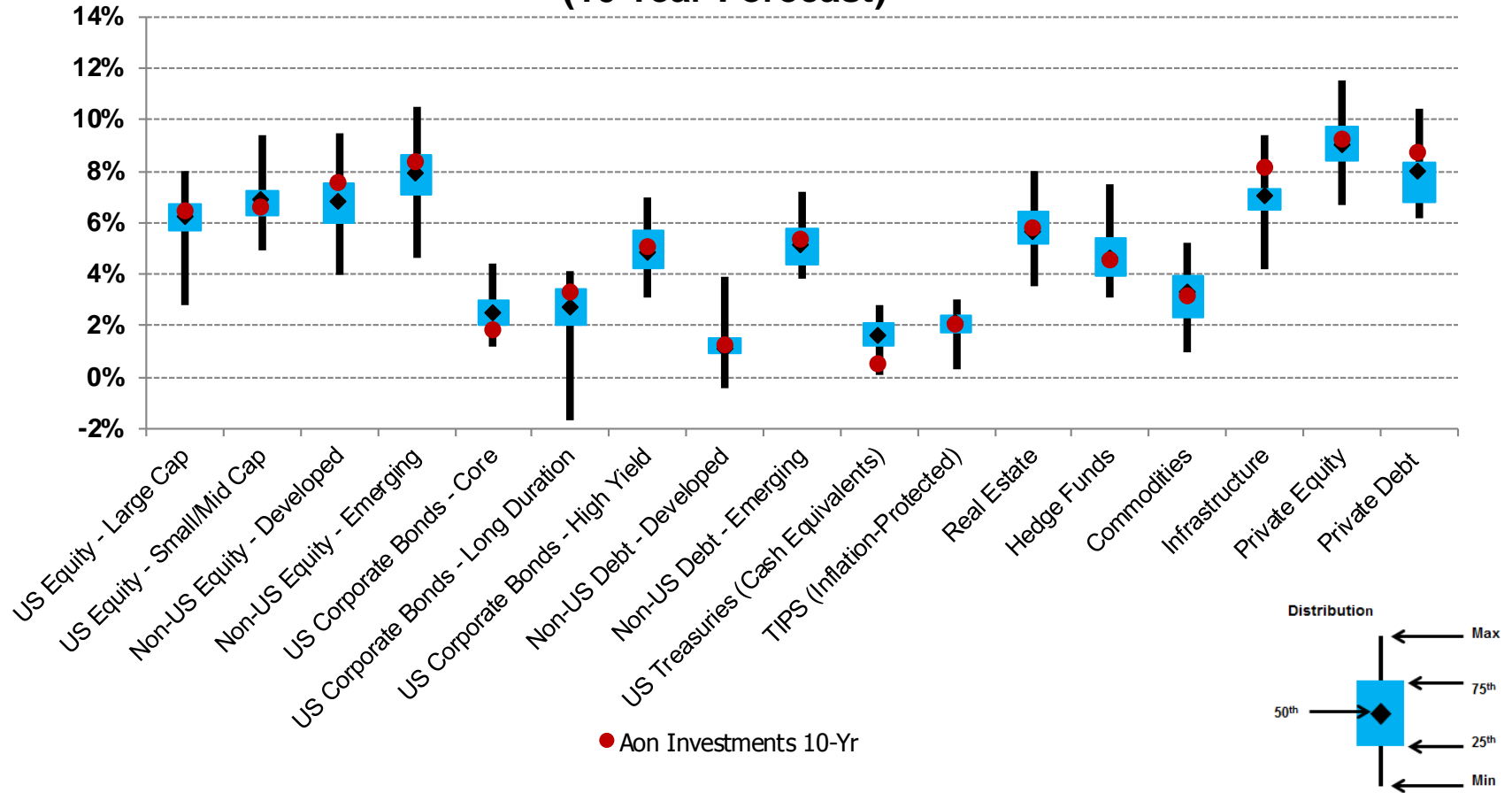
- Since 2010, Horizon Actuarial Services, LLC has conducted a capital market assumption survey of investment firms to aid in determining reasonable assumptions for a pension plan's expected return on assets
 - While Aon does not seek to change our approach based on how we stack up to peers, it is a helpful double-check to make sure we are not too far off from others in the industry

▪ How does Aon compare to the 2020 survey results?

- 2020 Aon Investments' 10-year forecast assumptions (as of March 31, 2020)
 - **Equities:** approximately middle of the pack for US equities and slightly higher for Non-US equities relative to the survey's median level
 - **Fixed Income:** approximately middle of the pack relative to the survey's median level; lower for US Treasuries
 - **Alternatives:** approximately middle of the pack relative to the survey's median level; slightly higher for Infrastructure and Private Debt

Aon Investments' Capital Market Assumptions vs. Horizon Survey

Expected Geometric Returns of 39 Investment Advisors (10 Year Forecast)



SOURCE: Horizon Actuarial Solutions, LLC survey of 2020 capital market assumptions from 39 independent investment advisors
 Expected returns of the survey are annualized over 10-years (geometric).
 Aon Investments' expected returns are annualized over 10-years as of 2Q 2020 (3/31/2020)

Aon Investments vs. Peers (2020 Horizon Survey)—10-Year Forecast

Asset Class	Horizon Survey		Aon Investments		Difference
	10 Year Horizon		10 Year Forecasts		
	Expected Return	Expected Risk	Expected Return	Expected Risk	
US Equity - Large Cap	6.2%	16.2%	6.4%	17.0%	Aon Investments- Horizon Survey 0.2%
US Equity - Small/Mid Cap	6.9%	20.2%	6.6%	23.0%	-0.3%
Non-US Equity - Developed	6.8%	18.1%	7.5%	20.0%	0.7%
Non-US Equity - Emerging	7.9%	24.2%	8.3%	27.0%	0.4%
US Fixed Income - Core	2.5%	5.5%	1.8%	4.0%	-0.7%
US Fixed Income - Long Duration Corp	2.7%	10.2%	3.3%	11.5%	0.6%
US Fixed Income - High Yield	4.8%	9.8%	5.0%	12.0%	0.2%
Non-US Fixed Income - Developed	1.1%	7.0%	1.2%	5.5%	0.1%
Non-US Fixed Income - Emerging	5.1%	11.0%	5.3%	13.0%	0.2%
Treasuries (Cash Equivalents)	1.6%	1.8%	0.5%	1.0%	-1.1%
TIPS (Inflation-Protected)	2.1%	6.1%	2.0%	4.5%	-0.1%
Real Estate	5.6%	16.8%	5.8%	15.0%	0.2%
Hedge Funds	4.6%	8.0%	4.5%	9.0%	-0.1%
Commodities	3.3%	17.6%	3.1%	17.0%	-0.2%
Infrastructure	7.0%	14.6%	8.1%	14.5%	1.1%
Private Equity	9.0%	22.0%	9.2%	25.0%	0.2%
Private Debt	8.0%	12.1%	8.7%	16.0%	0.7%
Inflation	2.0%	1.7%	2.1%	1.0%	0.1%

Notes (Horizon Survey):

Source: Horizon Actuarial survey of 2020 capital market assumptions from 39 independent investment advisors

Expected returns are median annualized (geometric).

Notes (Aon Investments' Forecasts):

Aon Investments' Forecasts are for Q2 2020

- US Equity - Small/Mid Cap forecasts represents Aon Investments' forecasts for US Small Cap
- US Fixed Income - Long Duration forecasts represents Aon Investments' forecasts for Long Duration Credit
- Non-US Fixed Income - Developed forecasts represents Aon Investments' forecasts for Non-US Fixed Income - Developed (50% Hedged)
- Non-US Fixed Income - Emerging forecasts represents Aon Investments' forecasts for Emerging Market Bonds - Sovereign USD
- Real Estate forecasts represents Aon Investments' forecasts for Core Real Estate
- Hedge Funds forecasts represents Aon Investments' forecasts for Direct Hedge Funds (Universe)

Leading Methodologies & Reasons for Differences

Leading Methodologies

- Building Block
- Global Capital Asset Pricing Model (Global CAPM)
- Surveys
- Historical data (as a guide to future)
- Black-Litterman (combination of building block and CAPM)

Reasons for Differences

- Methodology
- Time Horizon
- Arithmetic vs. Geometric forecasts*
- Alpha (active management)*
- Inflation
- Investment Fees*
- Asset class definition

* While some firms in the Horizon survey responded with arithmetic forecasts, the results have been converted to geometric forecasts for comparison purposes. Additionally, the return expectations included in the Horizon survey are generally market returns that do not reflect active management. Returns for asset classes where passive investments are not available (e.g., hedge funds and private equity) are net of fees.



Appendix

- Liquidity Analysis Detail (School Retirement System)

Background

Aon Investments' Approach to Analyzing Liquidity Risk from Alternatives

- Intended as a stress-testing model
- Develops multi-year projections of assets and spending needs
- Uses different scenarios for economic environments and other relevant events
- Shows how the portfolio's liquidity profile could evolve with a given investment strategy
- Incorporates the profile of the liabilities as well as expected future contributions

Background

Process Inputs and Outputs



Background

Modeling Parameters – Degrees of Illiquidity

- We categorized investments by liquidity into five buckets
 - **Liquid (Risk-Reducing Assets):** less than 3 months needed for return of capital (e.g., publicly traded securities)
 - **Liquid (Return-Seeking Assets):** less than 3 months needed for return of capital (e.g., publicly traded securities)
 - **Quasi-Liquid:** Typical lock-up of 3–12 months. Conservatively, we assumed a 1-year lock-up in most economic environments, 2 years in a Recession scenario, and 3 years in a Black Skies scenario (e.g., many hedge funds, core real estate)
 - **Illiquid: Potential lock-up of 5–10 years,** depending on economic environment (e.g., closed-ended real estate)
 - **Illiquid: Potential lock-up of 10+ years** (e.g., typical private equity)

- This is intended to be a conservative approximation of the actual liquidity properties of the assets

- We started with the target asset allocations, then see how the actual allocations would change in different economic scenarios, continuing new commitments to private assets, as expected.

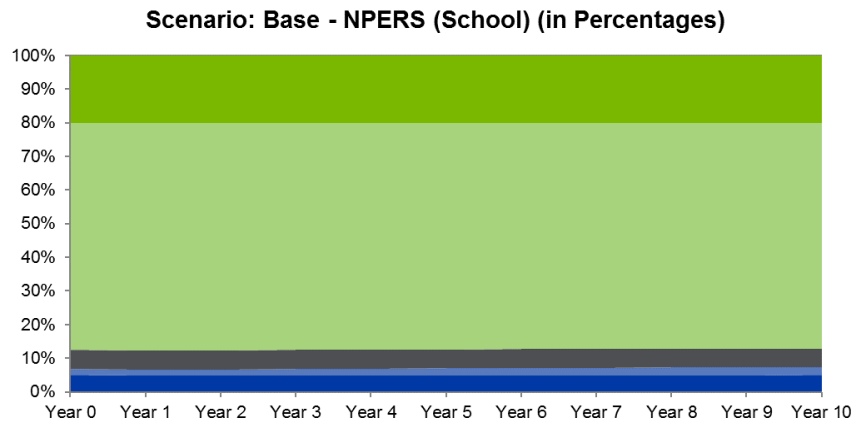
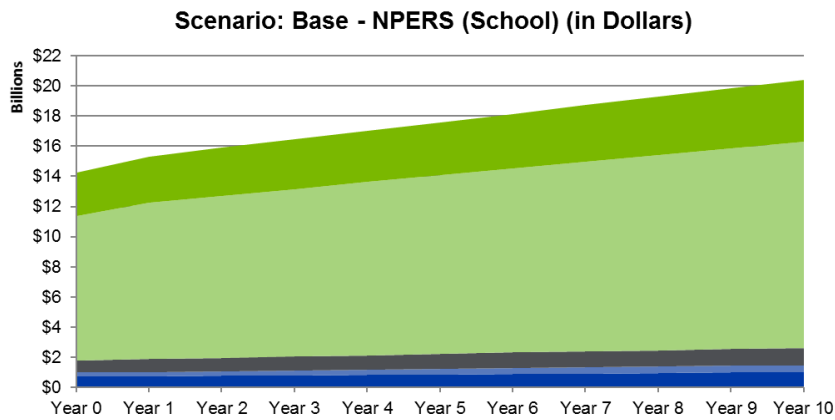
- Assumptions
 - Asset-liability information based on the July 1, 2020 actuarial valuation report, projections provided by the plan actuary, and asset experience through March 31, 2021
 - The plan’s contribution policy is determined in accordance with the methodology used by the plan actuary
 - Assumes the portfolio starts at the target asset allocation levels for illiquid assets, maintaining close to the portfolio targets over the next 10 years

Liquidity Analysis: Base Case Economic Scenario

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Base Case economic scenario, assuming commitments are continued as expected

■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid (Return-Seeking Assets) ■ Liquid (Risk-Reducing Assets)



Key Takeaway:

- Total illiquid and quasi-liquid assets are projected to stay near 12.5% of the Plan and can be maintained near the target with no cash flow problems

Note: Year 0 represents a starting point of March 31, 2021

Liquidity Analysis: Base Case Economic Scenario (continued)

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in a Base Case scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Liquid Return-Seeking	68	68	68	68	67	67	67	67	67	67	67
Total Liquid	88%	88%	88%	88%	87%	87%	87%	87%	87%	87%	87%
Quasi-Liquid	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Illiquid: 5-10 Year Lock-up	2	2	2	2	2	2	2	2	2	2	2
Illiquid: 10+ Year Lock-up	5	5	5	5	5	5	5	5	5	5	5
Total Quasi + Illiquid	13%	12%	12%	12%	13%	13%	13%	13%	13%	13%	13%

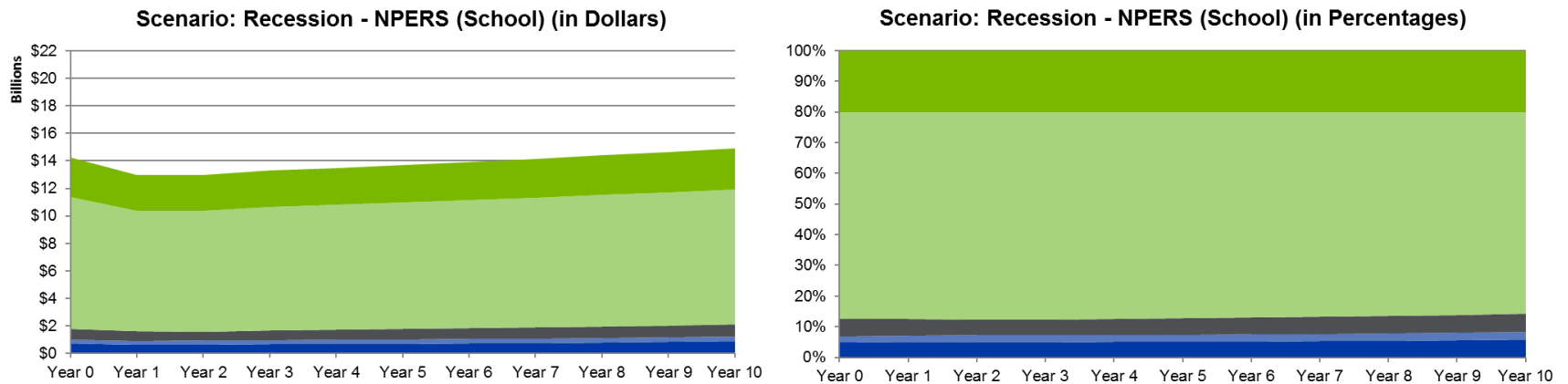
Note: Year 0 represents a starting point of March 31, 2021; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Recession Economic Scenario

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in the Recession economic scenario, assuming commitments are continued as expected

■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid (Return-Seeking Assets) ■ Liquid (Risk-Reducing Assets)



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but recessionary markets cause the total portfolio to shrink
- Total illiquid and quasi-liquid assets are projected to reach as high as 14% of the Plan due to the shrinking market value of the total Plan in this scenario
- There would not be a concern with the ability to pay benefits
- NPERS may need to redeem some quasi-liquid assets to stay close to its target allocation (12.5% illiquid assets)

Note: Year 0 represents a starting point of March 31, 2021

Liquidity Analysis: Recession Economic Scenario (continued)

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in a Recession scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Liquid Return-Seeking	68	67	68	68	67	67	67	67	67	66	66
Total Liquid	88%	87%	88%	88%	87%	87%	87%	87%	87%	86%	86%
Quasi-Liquid	6%	5%	5%	5%	5%	5%	6%	6%	6%	6%	6%
Illiquid: 5-10 Year Lock-up	2	2	2	2	2	2	2	2	2	2	3
Illiquid: 10+ Year Lock-up	5	5	5	5	5	5	5	5	5	6	6
Total Quasi + Illiquid	13%	13%	12%	12%	13%	13%	13%	13%	13%	14%	14%

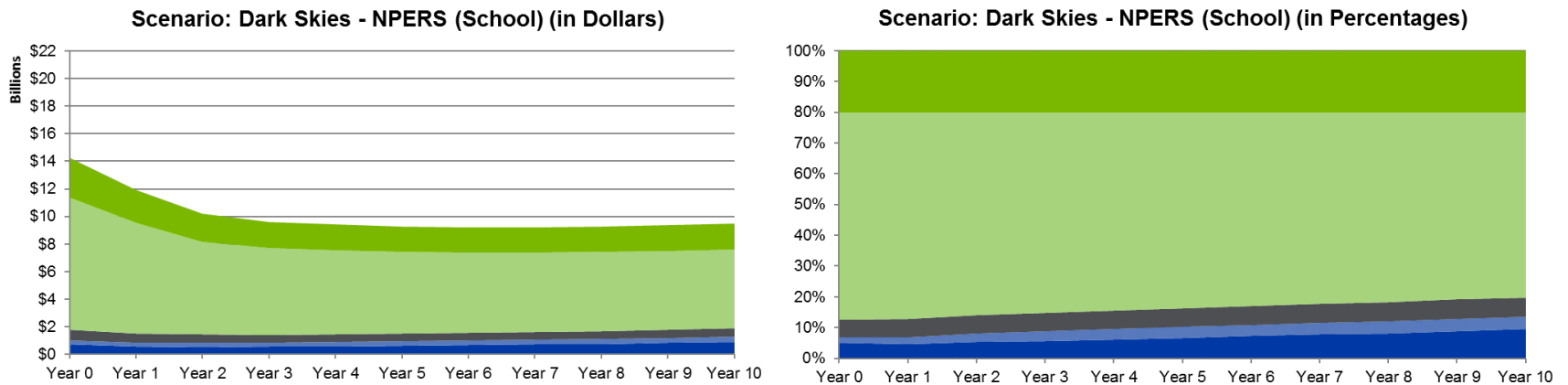
Note: Year 0 represents a starting point of March 31, 2021; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Dark Skies Economic Scenario

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in a Dark Skies scenario, assuming commitments are continued as expected

■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid (Return-Seeking Assets) ■ Liquid (Risk-Reducing Assets)



Key Takeaways:

- Commitments to illiquid alternatives are maintained at the steady state level, but subpar markets cause the total portfolio to shrink
- Total illiquid and quasi-liquid assets are projected to reach as high as 20% of the Plan due to the shrinking market value of the total Plan in this scenario
- There would not be a concern with the ability to pay benefits
- NPERS may need to redeem some quasi-liquid assets to stay close to its target allocation (12.5% illiquid assets)

Note: Year 0 represents a starting point of March 31, 2021

Liquidity Analysis: Dark Skies Economic Scenario (continued)

Current Policy

- The exhibit below shows the projected liquidity lock-up of the Current Policy allocation in a Dark Skies scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Liquid Return-Seeking	68	67	66	65	64	64	63	62	62	61	60
Total Liquid	88%	87%	86%	85%	84%	84%	83%	82%	82%	81%	80%
Quasi-Liquid	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Illiquid: 5-10 Year Lock-up	2	2	3	3	3	3	4	4	4	4	4
Illiquid: 10+ Year Lock-up	5	5	5	6	6	7	7	8	8	9	10
Total Quasi + Illiquid	13%	13%	14%	15%	16%	16%	17%	18%	18%	19%	20%

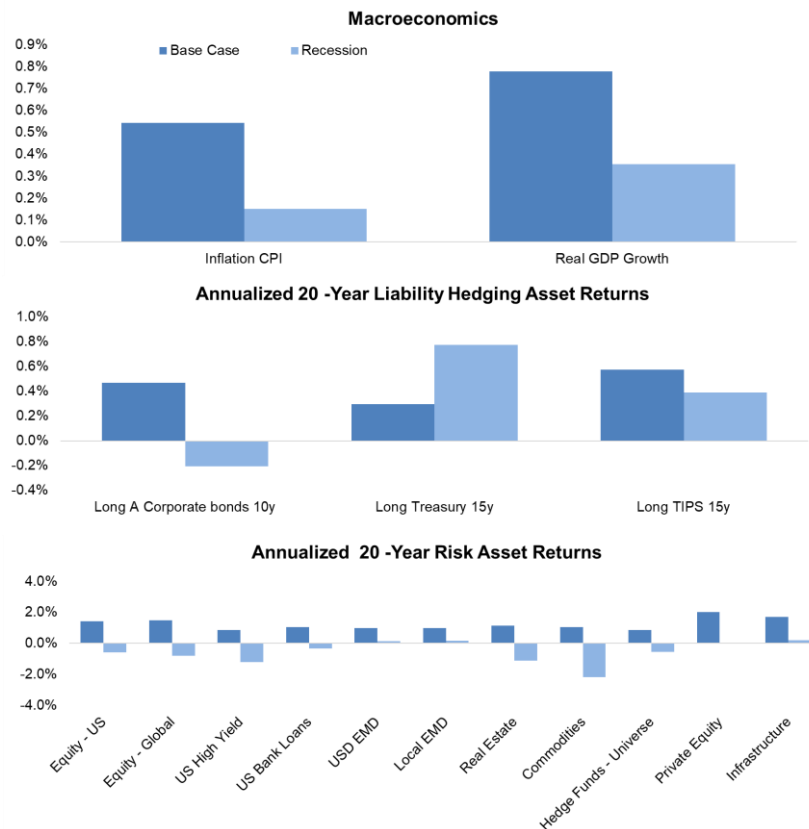
Note: Year 0 represents a starting point of March 31, 2021; Percentages may not sum to 100% due to rounding

Recession Scenario

Description

The US economy slips back into recession in 2021

- A resurgence of covid-19 infections driven by new variants necessitates further lockdown measures, as existing vaccines prove less effective and it takes time to develop, test and distribute updated vaccines.
- The global economy experiences a deeper recession than the base case, as containment measures weigh heavily on economic activity.
- The US experiences a deep recession in 2021.
- Inflation turns slightly negative in 2021. However, the period of deflation is short lived and inflation starts to rise in later years as an economic recovery begins to establish itself.
- Treasury yields fall while TIPS yields remain at low levels as the US enters recession. Yields rise in later years as a recovery gets underway. Corporate spreads rise significantly due to the poor economic situation and increased risks of downgrades or defaults.
- Most risk assets make losses in the first two years but rebound in later years as the economy recovers.



Returns from 31 March 2021

Source: Aon

The opinions referenced are as of the date of publication and are subject to change due to changes in the market or economic conditions and may not necessarily come to pass. Information contained herein is for informational purposes only and should not be considered investment advice.

Recession Scenario

Data Table

RECESSION SCENARIO

	Year										
	0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	1.0%	-0.4%	-0.4%	0.5%	0.9%	1.3%	1.5%	1.6%	1.7%	1.8%	1.8%
Long Treasury yield 15y	2.2%	0.2%	0.1%	1.1%	1.3%	1.5%	1.6%	1.7%	1.9%	1.9%	2.0%
TIPS yield 5y	-1.5%	-2.3%	-2.4%	-2.1%	-1.9%	-1.7%	-1.6%	-1.4%	-1.3%	-1.1%	-1.0%
Long TIPS yield 15y	-0.3%	-1.6%	-1.7%	-1.2%	-1.1%	-0.9%	-0.7%	-0.6%	-0.5%	-0.4%	-0.3%
Breakeven price inflation 15y	2.5%	1.8%	1.8%	2.3%	2.4%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%
A Corporate bond yield 5y	1.6%	3.5%	4.2%	4.5%	4.2%	4.3%	4.3%	4.2%	4.0%	3.9%	3.7%
Long A Corporate bond yield 10y	2.8%	3.4%	3.8%	4.4%	4.2%	4.2%	4.2%	4.1%	4.1%	4.0%	3.9%
A Corporate spread 5y	0.6%	3.9%	4.6%	4.0%	3.4%	3.0%	2.8%	2.6%	2.3%	2.1%	1.9%
Long A Corporate spread 10y	0.8%	3.3%	3.8%	3.4%	3.0%	2.7%	2.6%	2.4%	2.3%	2.1%	2.0%
Expected nominal return on assets											
Equity - US		-18.6%	-10.6%	10.1%	5.2%	5.2%	5.2%	5.3%	5.4%	5.4%	5.5%
Equity - Global		-21.4%	-12.2%	10.9%	5.4%	5.4%	5.5%	5.6%	5.6%	5.7%	5.8%
A Corporate bonds 5y		-5.6%	0.0%	4.3%	5.1%	4.0%	4.5%	4.6%	4.6%	4.6%	4.6%
Long A Corporate bonds 10y		-6.4%	-3.6%	-0.1%	4.3%	2.1%	2.3%	2.7%	2.9%	3.0%	3.2%
Treasury 5y		6.2%	0.1%	-1.4%	-0.6%	-0.1%	1.1%	1.3%	1.5%	1.6%	1.6%
Long Treasury 15y		28.8%	1.8%	-7.6%	-1.7%	-1.9%	-0.4%	0.0%	0.2%	0.5%	0.6%
Long Treasury 30y		58.3%	2.3%	-6.9%	-3.6%	-4.3%	-2.3%	-2.0%	-1.6%	-1.5%	-1.3%
TIPS 5y		1.9%	-0.3%	-0.7%	-0.8%	-0.5%	0.2%	0.4%	0.5%	0.6%	0.8%
Long TIPS 15y		16.5%	1.0%	-4.3%	-1.9%	-2.1%	-0.7%	-0.6%	-0.4%	-0.3%	-0.1%
US High Yield		-6.0%	-19.5%	-5.9%	6.7%	3.1%	3.0%	3.3%	3.4%	3.6%	3.7%
Bank Loans		-3.1%	-10.6%	-0.9%	5.2%	3.4%	3.0%	3.2%	3.3%	3.5%	3.6%
USD Emerging Market Debt		-17.2%	-10.6%	6.2%	4.2%	3.9%	4.1%	4.3%	4.4%	4.4%	4.5%
Local Emerging Market Debt		-16.9%	-10.2%	6.4%	4.1%	3.4%	4.2%	4.3%	4.4%	4.5%	4.5%
Real Estate		-13.6%	-8.5%	-3.3%	0.1%	4.0%	4.0%	4.1%	4.2%	4.2%	4.3%
Commodities		-28.0%	-22.1%	6.9%	3.5%	3.5%	3.6%	3.6%	3.7%	3.8%	3.9%
Hedge Funds - FoHF - Universe		-14.5%	-9.3%	6.2%	5.1%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Private Equity		-18.9%	-6.4%	13.1%	8.3%	8.5%	8.5%	8.4%	8.4%	8.4%	8.4%
Infrastructure - US		-5.7%	-1.3%	2.1%	2.9%	6.5%	6.6%	6.6%	6.7%	6.7%	6.8%
Cash		-0.2%	-0.8%	-0.5%	-0.2%	0.2%	0.5%	0.8%	1.1%	1.3%	1.4%
CPI		-0.1%	0.4%	0.7%	1.0%	1.2%	1.3%	1.4%	1.5%	1.6%	1.7%

Scenario information as of March 31, 2021

Dark Skies Scenario

Description

A deep recession followed by a longer period of stagnant growth

- New mutations of covid-19 lead to seasonal waves of infections, which necessitates ongoing containment measures, hampering economic activity.
- Economic weakness in developed and emerging market economies and severe levels of financial distress (due to high debt levels and political crisis) lead to a global recession followed by stagnation.
- The US experiences a protracted deep recession.
- Inflation is pushed into negative territory in 2021 and remains there in 2022, while continued sluggish growth over the following years means that inflation stays close to zero.
- Treasury yields fall and remain at low levels as the US enters recession. Corporate spreads rise significantly due to the poor economic situation and increased risks of downgrades or defaults.
- Risk assets make losses in the first few years. There is no pronounced bounce in growth and the economic situation remains poor for a long time, which weighs on returns in later years.

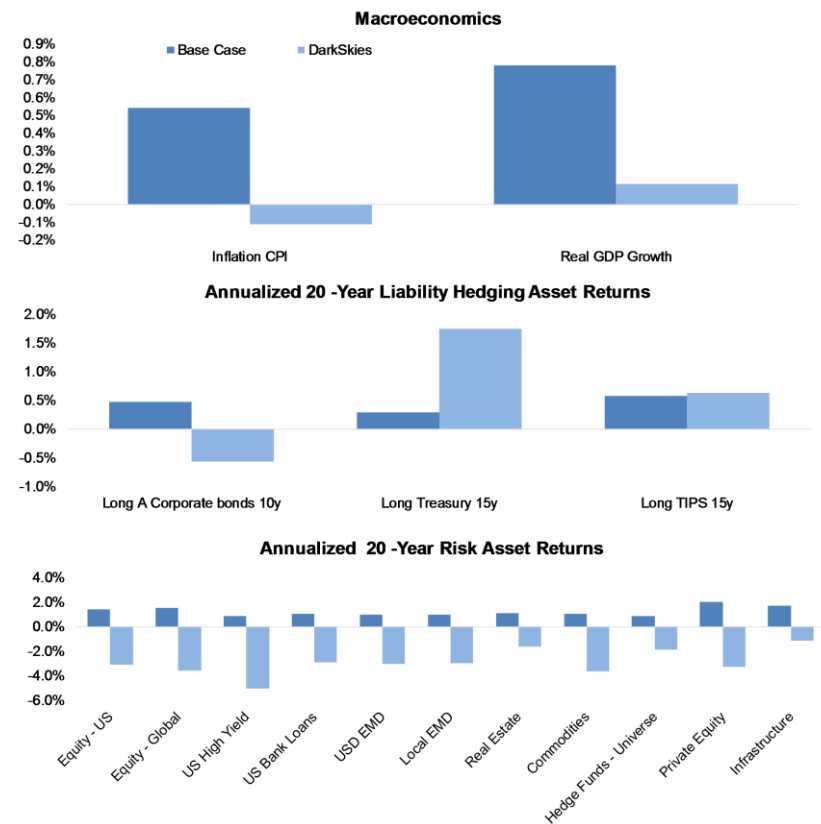
Returns from 31 March 2021

Source: Aon

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Proprietary & Confidential

Investment advice and consulting services provided by Aon Investments USA Inc.



Dark Skies Scenario

Data Table

DARK SKIES SCENARIO

	Year										
	0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	1.0%	-1.0%	-1.5%	-1.3%	-1.0%	-0.9%	-0.6%	-0.3%	0.0%	0.3%	0.5%
Long Treasury yield 15y	2.2%	-0.5%	-0.9%	-0.8%	-0.5%	-0.4%	-0.1%	0.1%	0.4%	0.6%	0.8%
TIPS yield 5y	-1.5%	-2.6%	-3.0%	-3.0%	-2.8%	-2.7%	-2.5%	-2.3%	-2.1%	-1.9%	-1.7%
Long TIPS yield 15y	-0.3%	-2.1%	-2.4%	-2.4%	-2.2%	-2.1%	-1.9%	-1.7%	-1.5%	-1.3%	-1.1%
Breakeven price inflation 15y	2.5%	1.6%	1.5%	1.6%	1.7%	1.7%	1.7%	1.8%	1.8%	1.9%	1.9%
A Corporate bond yield 5y	1.6%	4.4%	4.5%	4.4%	4.0%	3.8%	3.8%	3.7%	3.7%	3.6%	3.5%
Long A Corporate bond yield 10y	2.8%	3.8%	3.9%	3.8%	3.6%	3.4%	3.5%	3.5%	3.5%	3.5%	3.6%
A Corporate spread 5y	0.6%	5.4%	6.0%	5.7%	5.1%	4.6%	4.3%	4.0%	3.7%	3.4%	3.0%
Long A Corporate spread 10y	0.8%	4.4%	4.9%	4.7%	4.2%	3.9%	3.7%	3.4%	3.2%	3.0%	2.8%
Expected nominal return on assets											
Equity - US		-27.7%	-20.1%	-11.2%	2.2%	2.2%	2.6%	2.9%	3.3%	3.7%	4.0%
Equity - Global		-31.4%	-22.8%	-12.8%	2.1%	2.1%	2.5%	2.9%	3.3%	3.7%	4.1%
A Corporate bonds 5y		-9.8%	0.3%	1.8%	2.9%	1.6%	0.8%	1.1%	1.4%	1.6%	1.9%
Long A Corporate bonds 10y		-12.1%	-2.2%	0.8%	2.5%	0.5%	-1.0%	-0.6%	-0.2%	0.1%	0.5%
Treasury 5y		7.6%	1.5%	-1.0%	-1.4%	-1.7%	-2.0%	-1.7%	-1.4%	-1.0%	-0.7%
Long Treasury 15y		37.8%	6.0%	0.3%	-1.3%	-2.3%	-3.8%	-3.4%	-3.1%	-2.7%	-2.4%
Long Treasury 30y		83.3%	5.5%	0.6%	1.7%	-3.2%	-4.4%	-4.2%	-3.9%	-3.7%	-3.6%
TIPS 5y		1.1%	-1.2%	-1.4%	-2.1%	-2.2%	-1.9%	-1.6%	-1.4%	-1.1%	-0.8%
Long TIPS 15y		20.6%	1.2%	-1.1%	-2.9%	-3.3%	-3.9%	-3.7%	-3.3%	-3.0%	-2.7%
US High Yield		-10.2%	-36.0%	-26.8%	-14.1%	-2.1%	-2.5%	-1.9%	-1.2%	-0.6%	0.1%
Bank Loans		-5.9%	-23.7%	-16.9%	-7.5%	0.2%	0.1%	0.6%	1.0%	1.4%	1.8%
USD Emerging Market Debt		-24.9%	-19.0%	-11.3%	0.2%	0.4%	1.6%	1.9%	2.2%	2.5%	2.8%
Local Emerging Market Debt		-24.6%	-18.6%	-11.1%	0.1%	0.1%	1.6%	2.0%	2.3%	2.6%	2.9%
Real Estate		-15.2%	-10.9%	-5.3%	-1.0%	1.1%	1.5%	1.8%	2.2%	2.5%	2.9%
Commodities		-35.1%	-27.1%	-3.6%	2.1%	2.1%	2.3%	2.5%	2.7%	3.0%	3.2%
Hedge Funds - FoHF - Universe		-17.4%	-12.2%	-6.6%	0.4%	0.4%	0.7%	1.0%	1.3%	1.6%	1.9%
Private Equity		-30.8%	-22.3%	-11.6%	4.3%	4.3%	4.7%	5.1%	5.5%	5.9%	6.3%
Infrastructure - US		-12.5%	-8.3%	-4.5%	0.5%	3.1%	3.5%	3.9%	4.3%	4.7%	5.1%
Cash		-0.2%	-1.1%	-1.1%	-1.0%	-0.9%	-0.6%	-0.3%	0.0%	0.3%	0.5%
CPI		-1.6%	-1.4%	0.0%	0.2%	0.4%	0.6%	0.7%	0.9%	1.1%	1.3%

Scenario information as of March 31, 2021



Appendix

- How Do Public Pensions Impact Credit Ratings?

How Do Public Pensions Impact Credit Ratings?

Summary and Conclusions

Pension Impact on Credit Ratings

- Pension plans have a direct impact on the ultimate state or local credit rating
- Rating agencies are not just looking at where public pension plans stand today; they are looking at the expected future trajectory of the plan based on how it is managed

Credit Ratings and Borrowing Costs

- Taxpayers in lower credit rated jurisdictions are paying higher borrowing costs and could save money through healthier pension plan management




Call to Action

- The Big Three value selecting appropriate actuarial assumptions, avoiding excessive risk taking, and developing an adequate funding policy
- While debt priorities and revenue framework to service such debt will vary on a case-by-case basis, every jurisdiction has the ability to thoughtfully develop a funding policy and set appropriate assumptions
- These initial steps will help pension stakeholders better understand the true economic costs, improve the funding outlook for public pensions, and potentially reduce borrowing costs and further taxpayer burden

How Do Public Pensions Impact Credit Ratings?

Call to Action: Plan Sponsors Have Ability to Impact Credit Rating

Below are three specific actions plan sponsors can take today to directly improve the impact a pension plan will have on the credit rating of its locality:

	Action	Considerations
	<p>1. Conduct an actuarial assumption audit</p> <ul style="list-style-type: none">Review reasonability of key assumptions:<ul style="list-style-type: none">Salary scale, Mortality, Retirement rates, Turnover rates	<ul style="list-style-type: none">Assumptions set to plan-specific expectations will lead to lower contribution volatilityAggressive assumptions may provide short-term relief but may have long-term consequences
	<p>2. Consider adjustments to expected return assumption</p> <ul style="list-style-type: none">Adjustments should be in line with forward-looking expectations for asset returns	<ul style="list-style-type: none">Contributing an actuarial amount?<ul style="list-style-type: none">Yes: Failing to achieve target returns will necessitate increases in future contributions and make what was intended to be a smooth, budget-friendly progression of contribution increases far more volatileNo: The funding gap will widen and become highly volatile as contribution policy will not add enough dollars to replenish losses
	<p>3. Review the plan's funding policy</p> <ul style="list-style-type: none">Look far enough into the future to identify potential pain points	<ul style="list-style-type: none">Conduct "tread water"/hurdle rate analysis to ensure short-term contributions are sufficient to keep pace with growth of plan liabilitiesConsider asset-liability study to understand range of potential future outcomes rather than a single deterministic scenario



Appendix

- Asset-Liability Management Background

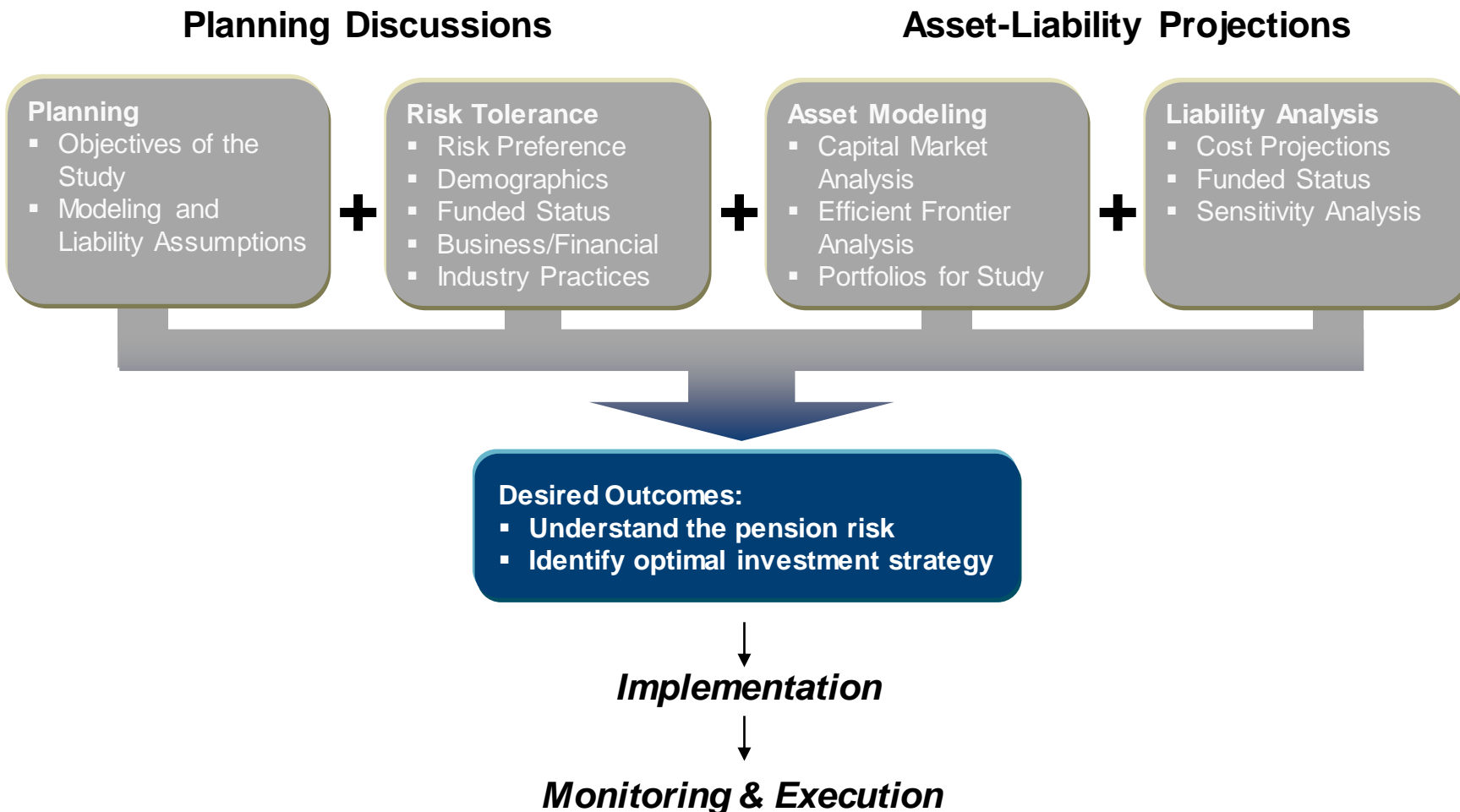
Asset-Liability Management Background

Key Risks for Public Pension Plans

Types of Risk	Time Horizon	Risk Management Tools and Controls
Return Shortfall <ul style="list-style-type: none"> ▪ Assets do not grow with liabilities ▪ Investment Return & Contribution less than Liability Growth 	Long Term (10+ years)	<ul style="list-style-type: none"> ▪ Funding Policy ▪ Plan Design ▪ Investment Policy ▪ Assumptions & Methods
Liquidity <ul style="list-style-type: none"> ▪ Cannot liquidate assets efficiently to meet needs ▪ Lost control of asset allocation 	Short to Medium Term (<5 years)	<ul style="list-style-type: none"> ▪ Funding Policy ▪ Benefit Accruals ▪ Use of Illiquid Investments ▪ Scenario Analysis ▪ Monitoring
Investment <ul style="list-style-type: none"> ▪ Asset Allocation (Policy) ▪ Investment Structure ▪ Manager Selection ▪ Rebalancing ▪ Scenario (or Path Risk) ▪ Factor 	Short to Medium Term (<5 years)	<ul style="list-style-type: none"> ▪ Investment Policy Statement <ul style="list-style-type: none"> – Static/Dynamic – Asset Allocation – Rebalancing – Manager Guidelines – Monitoring/Roles & Responsibilities ▪ Risk Budgeting Tools ▪ Monitoring / Dashboards ▪ Medium Term Views ▪ Regression and Scenario Analysis
Other (e.g., Operational)	Ongoing	<ul style="list-style-type: none"> ▪ Operational and Specialty Due Diligence

Asset-Liability Management Background

Overview of the Asset-Liability Study Process



Asset-Liability Management Background

Modeling Process

- Goals of an asset-liability study:
 - Understand the pension plan's asset-liability risk, and
 - Identify the optimal investment strategies

- Stochastic, Monte Carlo simulation analysis used
 - 5,000 independent economic trials
 - Building block approach
 - Starts with inflation and interest rates
 - Using a multi-factor regression analysis, other asset classes are then modeled
 - Assets and liabilities are modeled over the projection period
 - Projections include contribution requirements and funded ratios

- Asset-liability studies are best-suited to determine the optimal mix of return-seeking (e.g., equity) and fixed income assets for the pension fund
 - Asset mix is the single most important investment decision for the plan sponsor
 - Is it worthwhile to have a more aggressive allocation in order to reduce long term cost in exchange for risk of higher costs in a bad outcome?
 - Is it worthwhile to have a more conservative allocation in order to have a more predictable cost in exchange for potentially higher average costs?

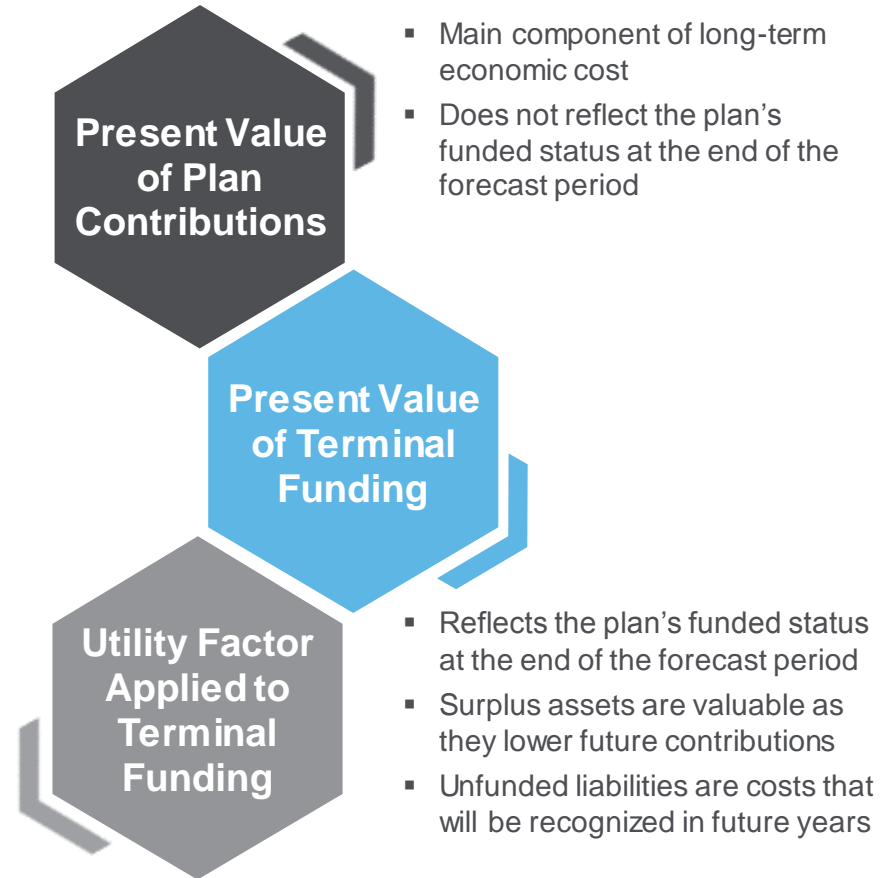
Asset-Liability Management Background

Long-Term Economic Cost of Plan

Long-Term Economic Cost =

- **Present Value of Plan Contributions +**
- **Present Value of Terminal Funding, adjusted by a utility factor**

Terminal Funding	Surplus	Shortfall
Utility Rationale	Declining value, or utility, from very high funded ratios	Increasing “pain” as unfunded amounts grow to high levels
Threshold	PVB / AL	(5 Yrs. of Benefit Payments) / AL
Utility Factor above/below threshold	50%	200%



Asset-Liability Management Background

Utility Factor For Terminal Funded Status

- Modest deviations from 100% funding are normal, and no special adjustment is needed for these scenarios – the amount of surplus or unfunded liability can be reflected at its dollar value

- As surplus amounts grow to very high levels, there is a declining value, or utility, to the surplus:
 - Contributions cannot go below zero
 - Long contribution holidays may create a false sense of how much the plan really costs, and lead to confusion when cost levels revert to “normal”
 - Large surplus amounts can become a potential target for non-pension applications

- As unfunded amounts grow to very high levels, there is an increasing amount of “pain” as contributions rise to unacceptable levels:
 - May be viewed as “breaking trust” with future taxpayers
 - Freezing of the pension plan becomes a possibility

Asset-Liability Management Background

Risk and Return in an Asset-Liability Context

- **Traditional:**

- Return = Investment performance
- Risk = Annual volatility of investment gains and losses (e.g., weak/negative capital market returns)

- **Asset-Liability:**

- Return = Potential cost reduction or funded status improvement under average economic conditions
- Risk = During the worst economic conditions, contributions need to increase or funded status declines (e.g., stocks decline, inflation/deflation shocks and/or interest rates decline)

Asset-Liability Management Background

Key Factors Affecting the Risk/Reward Trade-off

- The key take-away from the AL study is the allocation between equity (“return-seeking”) vs. fixed income (“risk-reducing”)

- Major factors affecting the ultimate mix are:
 - Time horizon (or amortization period of unfunded liability) to fund the liability: a longer time horizon supports more risk taking
 - Characteristics of plan participants: a growing population of active participants supports more risk taking; a mature population with significant retirees might need a more conservative policy
 - Funded status: a less funded plan can utilize additional returns from equity investments
 - Nature of plan benefits: a pension with sensitivity to wage inflation growth can benefit from equities in the long-term; an increased need in liquidity due to significant benefit payments in the near future can have a more conservative policy

Asset-Liability Management Background

Limitations of Asset-Liability Modeling

- Asset-liability studies are best-suited to determine the optimal mix of return-seeking (e.g., equity) and liability-hedging (e.g., fixed income) assets for the retirement fund
 - Asset mix is the single most important investment decision for the plan sponsor
 - Studies have found that more than 90% of the variability of a portfolio's return is determined by the asset allocation
 - Decisions regarding how to divide allocations among various sub-categories are less important in an asset-liability context and can be addressed in the implementation phase, following the asset-liability study
- Asset-liability modeling can capture the likelihood of a strategy meeting the objectives
 - It does not 'predict' the future, i.e., we cannot say which of the economic scenarios will actually occur
 - The results depend on the assumptions underlying the model and the structure of the model itself
- There are elements that cannot be modeled and must be thought of in addition to the results of any analysis:
 - E.g., idiosyncratic manager risk, liquidity requirements
 - Black swans



Appendix

- About This Material

About This Material

This material includes a summary of calculations and consulting related to the finances of Nebraska Public Employees Retirement System (NPERS). The following variables have been addressed:

- Contributions, Economic Cost, Funded Ratio, Hurdle Rate, Liquidity, Net Outflow

This analysis is intended to assist the Investment Committee with a review of the associated issues and options, and its use may not be appropriate for other purposes. This analysis has been prepared solely for the benefit of the Investment Committee. Any further dissemination of this report is not allowed without the written consent of Aon Investments USA Inc.

Our calculations were generally based on the methodologies identified in the actuary's valuation report for NPERS. We believe the methodology used in these calculations conforms to the applicable standards identified in the report.

Models are used to develop alternative scenarios based on the underlying valuation model and project financial results under those scenarios. The models were developed by experts outside and within Aon. Where outside models were used, the models were reviewed by experts within Aon. The models were selected as appropriate for these projections by the undersigned.

Experience different than anticipated could have a material impact on the ultimate costs of the benefits. In addition, changes in plan provisions or applicable laws could have a significant impact on cost. Actual experience may differ from our modeling assumptions.

Our calculations were based on data provided by the plan actuary. The actuarial assumptions and methods and plan provisions reflected in these projections are the same as those used for the 2020/21 Fiscal Year actuarial valuations for NPERS as noted in the actuarial reports, except where noted in this report. Unless specifically noted, our calculations do not reflect any other changes or events after July 1, 2020 (for the School, State Patrol, and Judges Plans) or January 1, 2021 (for the State and County Cash Balance Plans). Reflecting events after such dates would impact the results of the projection.

In conducting these projections, we have relied on plan design, demographic and financial information provided by other parties, including the plan's actuary and plan sponsor. While we cannot verify the accuracy of all of the information, the supplied information was reviewed for consistency and reasonableness. As a result of this review, we have no reason to doubt the substantial accuracy or completeness of the information and believe that it has produced appropriate results.

These projections have been conducted in accordance with generally accepted actuarial principles and practices, including applicable Actuarial Standards of Practice as issued by the Actuarial Standards Board. The undersigned actuary is familiar with the near-term and long-term aspects of pension valuations and meet the Qualification Standards of the American Academy of Actuaries necessary to render the actuarial opinions contained herein. All sections of this report are considered an integral part of the actuarial opinions.

To our knowledge, no colleague of Aon Investments USA Inc. providing services to NPERS has any direct financial interest or indirect material interest in NPERS. Thus, we believe there is no relationship existing that might affect our capacity to prepare and certify this report for NPERS.

Aon Investments USA Inc.

Phil Kivarkis FSA, CFA

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