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To: **State of Michigan Investment Board**

From: Max Kotary, CFA
Stephen Cummings, CFA
Phil Kivarkis, FSA, CFA
John Sullivan

Date: January 23, 2023

Re: SPRS OPEB Asset-Liability Study – Executive Summary

Overview and Summary

The purpose of this memorandum is to provide a review of the current Asset-Liability (A-L) profile of the Michigan State Police Retirement System (SPRS) OPE Plan and summarize the conclusions that can be drawn from the Asset-Liability Study that Aon recently completed on the Plan. We also provide answers to frequently asked questions relating to our A-L Studies, for reference.

Current A-L Profile: State of Michigan Summary

The State of Michigan offers the following pension and OPEB plans, with asset-liability characteristics shown in Figure 1 below as of September 30, 2021[1] – the most recent actuarial valuation reports available.

Figure 1

		(In $ millions)				
Pension	**Discount Rate**	**Market Value of Assets**	**Actuarial Liability**	**Funded Ratio**	**Liability Growth Rate**	**Asset Hurdle Rate**
- *Michigan Public Schools Employees' Retirement System*	6.00%	$63,332.2	$95,903.4	66.04%	7.12%	10.78%
- *Michigan State Employees' Retirement System*	6.00%	$14,481.6	$19,799.4	73.14%	6.19%	8.46%
- *Michigan State Police Retirement System*	6.15%	$1,842.5	$2,609.3	70.61%	7.25%	10.27%
- *Michigan Judges' Retirement System*	6.00%	$299.9	$266.4	112.61%	6.70%	5.95%
- *Military Retirement Provisions*	6.00%	$67.6	$63.9	105.86%	7.97%	7.53%
- *Total Pension*		$80,023.8	$118,642.3	67.45%	6.97%	10.33%
OPEB						
- *Michigan Public Schools Employees' Retiree Health Benefits*	6.00%	$10,742.2	$12,376.9	86.79%	6.61%	7.61%
- *Michigan State Employees' Retiree Health Benefits*	6.20%	$5,082.3	$8,814.6	57.66%	7.26%	12.58%
- *Michigan State Police Retiree Health Benefits*	6.25%	$372.9	$780.1	47.80%	7.46%	15.61%
- *Michigan Judges' Retiree Health Benefits*	6.00%	$11.8	$8.1	145.98%	8.99%	6.16%
- *Total OPEB*		$16,209.1	$21,979.8	73.75%	6.90%	9.35%

[1] September 30, 2021 represents the starting point of our analysis as it is the most recent actuarial liability detail available; for our projections, we have overlaid actual return experience through June 30, 2022 to allow our analysis to be as up-to-date as possible

Purpose of the A-L Study

The cost ultimately borne by the Plan will be represented by the financing equation shown below:

The asset-liability study will analyze the variability of future investment returns on the Plan financials

- Higher than expected returns will result in lower future costs
- Lower than expected returns will result in higher future costs

Key Observations from the A-L Study

Below we summarize what we view to be the key observations from the A-L Study on the SPRS OPEB Plan.

1. The SPRS OPEB plan is currently underfunded (47.80% as of 9/30/2021) which suggests a growth-oriented investment portfolio is reasonable.
2. SPRS' funding gap will be filled by a combination of plan contributions and investment returns.
    a. Contribution policy will take the plan to a fully funded state regardless of the investment strategy modeled due to the unique characteristics of the plan's funding policy. (These characteristics are explored in detail within the A-L Study and are addressed in summary fashion in the Q&A section of this memorandum.)
    b. The expected return for the current asset allocation targets based on our current capital market assumptions exceeds the ultimate actuarial rate of return (6.00%); that margin will help to close the funding shortfall over time while also providing buffers to mitigate future contribution volatility, alleviating some of the burden on future contributions.
3. SPRS' mix of return-seeking asset classes aligns reasonably well with our best thinking for portfolio construction.
    a. In Figure 2, we compare SPRS' existing asset allocation targets to Aon's Public Fund "Model Portfolios", scaled to SPRS' current level of return-seeking assets (i.e., 87.5% R-S) and the studied alternative portfolio
        i. Aon's Model Portfolios are designed to be representative of Aon's best thinking for Public Sector Defined Benefit/OPEB Plans across a range of different plan circumstances. (By 'plan circumstances' we are referring to things such as internal staffing levels, tolerance for illiquidity, tolerance for complexity, etc.) Our Model Portfolios are not one-size fits all; rather, they are meant to be used as a starting point for asset allocation analysis and decision making.
            1. Aon Model (Liquid) Portfolio = Appropriate for public pension/OPEB plans with a low level of resources or tolerance for portfolio complexity.
            2. Aon Model (Less Liquid) Portfolio = Appropriate for public pension/OPEB plans with modest internal resources and a relatively low tolerance for complexity and illiquidity.

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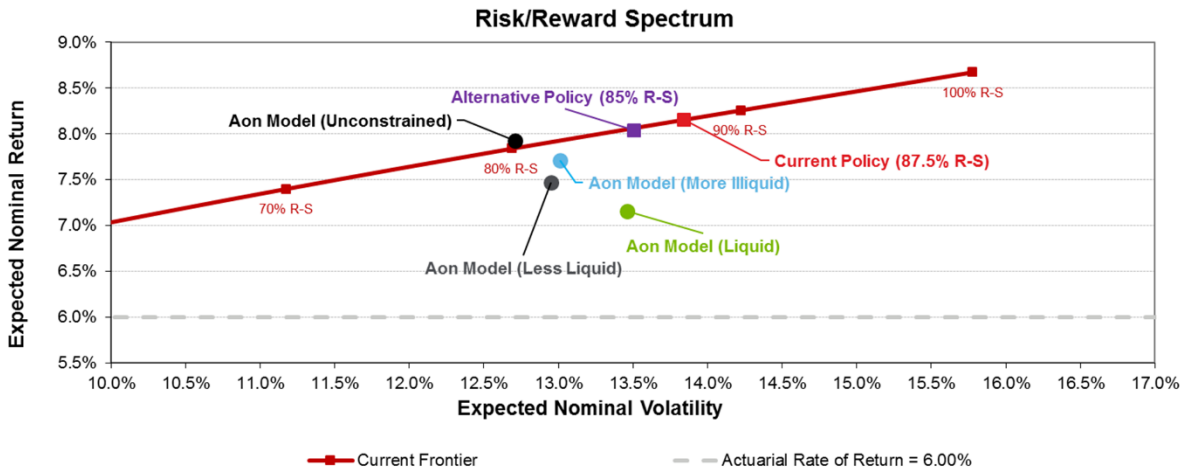
3. Aon Model (More Illiquid) Portfolio = Appropriate for public pension/OPEB plans with an average level of internal resources and tolerance for complexity and illiquidity.
4. Aon Model (Unconstrained) Portfolio = Appropriate for public pension/OPEB plans with deep internal resources and a high tolerance for complexity and illiquidity.

Figure 2



b. Key takeaways from Figure 2:
   i. SPRS' Current & Alternative Policies have a higher long-term return forecast than any Aon Model Portfolio.
   ii. SPRS' current policy is more efficient than three of the four Aon Model Portfolios [i.e., its frontier plots above Aon Model (Liquid), Aon Model (Less Liquid), and Aon Model (More Illiquid)].
      1. The red line is representative of SPRS' exiting policy scaled to different levels of return-seeking (R-S) assets.
   iii. SPRS' Current & Alternative Policies model as more volatile (i.e., has a higher standard deviation of forecasted investment returns) than the Aon Model portfolios.
      1. This is being driven, at least in part, by SPRS' existing policy having a higher allocation to equities (public + private), particularly relative to Aon Model (Unconstrained).

4. From an overall investment risk-posture standpoint, we find that:
   a. Higher risk asset allocation policies will be assumed to have lower plan contributions over time but with more volatility of contributions.
   b. Lower risk asset allocation policies will be assumed to have higher plan contributions over time but with less volatility of contributions.
5. All else equal, we believe SPRS would benefit from reducing its investment risk posture, at least at the margin. The Alternative policy presented has appeal for the following reasons:
   a. Better liquidity to support increasing net outflows in the coming years

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b. Better alignment between the discount rate (i.e., what the plan assets are *assumed to earn*) and what the assets are *expected to earn* under the **base case** scenario

c. Better performance in a **downside** scenario.

6. Figure 3 includes our recommended asset allocation targets for SPRS; these targets are what is modeled as "Alternative Policy" in Figure 2.

   a. We have also included recommendations for permissible ranges around these targets in Figure 3.

Figure 3

Asset Class	Current Policy (87.5% R-S)	Alternative Policy (85% R-S)	Difference	Current Rebalancing Ranges	Alternative Rebalancing Ranges
Equity					
- U.S. Equity	25.0%	25.0%	--	17% - 32%	17% - 32%
- International Equity	15.0%	15.0%	--	12% - 22%	12% - 22%
- Private Equity	16.0%	16.0%	--	13% - 25%	13% - 27%
- Subtotal	56.0%	56.0%	--		
Absolute Return / Liquid Alternatives					
- Subtotal	9.0%	9.0%	--	5% - 11%	5% - 11%
Real Return / Opportunistic					
- Subtotal	12.5%	10.0%	(2.5%)	8% - 18%	8% - 18%
Real Estate & Infrastructure					
- Subtotal	10.0%	10.0%	--	8% - 18%	8% - 18%
Risk-Reducing					
- Short-Term Fixed Income (Cash)	2.0%	2.0%	--	1% - 8%	1% - 8%
- Long-Term Fixed Income (Core Fixed Income)	10.5%	13.0%	+2.5%	8% - 18%	8% - 18%
- Subtotal	12.5%	15.0%	--		
Expected Return[1]	**8.16%**	**8.04%**	**(0.12%)**		
Expected Risk[1]	13.84%	13.50%	(0.34%)		
Sharpe Ratio	0.38	0.38	--		
Probability of Meeting/Exceeding 6.00%	**81%**	**80%**	**(1.0%)**		
1-Year Downside Return (2 Standard Deviations)	**-18.6%**	**-18.1%**	**+0.5%**		
Illiquid Assets	**47.1%**	**44.6%**	**(2.5%)**		

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Frequently Asked Questions

Q: What is an A-L Study?

A: An asset-liability study is a comprehensive review of a pension/OPEB plan's assets and liabilities. Utilizing an A-L Study to assist in setting fund asset allocation policy is generally considered to be a best practice amongst public pension systems.

Q: What is the purpose of an A-L Study?

A: An A-L Study provides a toolkit for making decisions on a fund's asset allocation and level of investment risk to best align the plan's assets with the liabilities the fund supports. The study describes the balance between the potential variability of investment returns and the variability of cash flows (contributions) funding the plan. Aon believes optimal decisions regarding pension/OPEB 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. By conducting an A-L Study we can better ascertain the risk preferences of the plan sponsor to best achieve the plan's goals.

Q: How is the A-L Study put together?

A: Aon works with the plan's actuary, in this case GRS, to get a clear understanding of the current benefit structure and funding policy (i.e., forecasted cash inflows and outflows). We then use Aon's proprietary Asset-Liability Model to generate up to 5,000 economic scenarios over the next ten-to-thirty years using a Monte Carlo simulation process. Key variables we simulate for the liabilities include inflation, interest rates, and pay increases. We also simulate asset class returns. These simulations lead to a projection of assets and liabilities under all economic scenarios for various asset allocation policies, allowing us to illustrate expected risk-reward tradeoffs in terms of investment return, cash contributions, funded status, and net outflow.

Q: How does one read the Study?

A: In its most basic sense, an A-L Study outlines risk/reward tradeoffs of various asset allocation policies. Instead of simply evaluating tradeoffs in terms of returns and volatility of returns, the A-L Study incorporates the liabilities to allow for the evaluation of risk/reward in terms of cash contributions, funded status, and net outflow. The Study presents these tradeoffs in the form of a distribution of potential outcomes, highlighting the 95^{th}, 75^{th}, 50^{th}, 25^{th}, and 5^{th} percentile outcomes for each asset allocation policy considered. To better illustrate risk vs. reward, the Study often contrasts the median outcome ("Expected") with the 95^{th} or 5^{th} percentile outcome ("Downside") for the various asset allocation policies considered.

Q: Does the Study rely on stochastic analysis or deterministic analysis?

A: We believe both types of analysis are important and incorporate both within our A-L Studies. Most of the forecasts presented in our A-L Study are stochastic in nature and are based on 5,000 economic scenarios that are generated using a Monte Carlo simulation process. These forecasts are designed to encompass the full range of potential economic outcomes over the period being analyzed. We also include deterministic analyses in our A-L Studies that help answer the question "What might the impact be on the plan's funded ratio, contribution policy, etc. if X environment were to occur?" Our deterministic analyses focus on downside scenarios (e.g., Recession, Depression) and are designed to help take the concept of downside risk out of the abstract and tie it to a tangible economic scenario.

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Q: What are some limitations of asset-liability modeling?

A: Asset-liability studies are best-suited to determine the optimal mix of return-seeking (e.g., equity) and risk-reducing (e.g., fixed income) assets. 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 that are highly correlated and have similar risk profiles are less important in an asset-liability context. Additionally, asset-liability modelling can capture the likelihood of a strategy meeting the plan sponsor's objectives. It does not 'predict' the future, i.e., we cannot say which of the economic scenarios included in our modelling will occur. The results depend on the assumptions underlying the model and the structure of the model itself. There are also variables that cannot be modelled effectively and must be considered in addition to the results of any analysis – e.g., idiosyncratic manager risk, liquidity requirements, black swan events, etc.

Q: What are the key assumptions used in this Study?

A: On the asset side of the equation, we use assumptions for capital market returns, standard deviation of returns (volatility), and correlation of returns. These assumptions are developed and maintained by our capital markets modeling team and updated on a quarterly basis; detail on these assumptions can be found in the Appendix of the Study. On the liability side, our analysis relies on data from the plan actuary combined with Michigan's specific contribution policy – inclusive of closed amortization period, Dedicated Gains Policy (where still applicable), etc.

Of note, our Study assumes that existing contribution/benefits structure remains in place throughout the duration of our analysis.

Q: What is Michigan's Dedicated Gains Policy and how does it work?

A: Adopted in 2017, the Dedicated Gains Policy established a framework to systematically reduce the actuarial assumed rate of investment return used to measure the plan liability when actual investment returns exceed pre-determined actuarial increments. After periods of strong returns (i.e., actual returns exceeding assumed returns), the Dedicated Gains Policy will lower the actuarial return assumption, increase the plan liability, but maintain similar plan contribution levels both before and after the change to the assumed return. After periods of poor returns (i.e., actual returns lagging assumed returns), there would be no changes to the actuarial assumption and plan contributions would increase, re-setting the floor for how low contributions can go in the future. Therefore, annual contributions are not projected to decline under the current contribution policy until the Dedicated Gains Policy exhausts and reaches its minimum threshold (6.00%) or the plan reaches full funding. **The SPRS OPEB current actuarial rate of return is 6.25%.**

Q: What is the amortization policy for contributions?

A: Michigan utilizes a closed amortization approach whereby all unfunded liability is amortized over a specific number of years, reducing by one annually until immediate recognition of (gains)/losses. **Due to the specific point in time that the liability is expected to be fully funded, the forecasted volatility of contributions will increase significantly as that point in time approaches as there are fewer and fewer years across which to spread the cost of any remaining unfunded liability.**

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Q: Does an A-L Study consider changes to contribution policy?

A: Most typically no, but on occasion we have employed our asset-liability model to analyze the impact of various changes in the benefit structure or funding policy to the future funded status of a plan.

Q: How might changes to contribution policy impact the results of the study?

A: It is difficult to say and would depend upon the specifics of the changes. In very broad terms, we would comment that modifications to (or the removal of) the more unique aspects of SPRS' contribution policy – i.e., the Dedicated Gains Policy and/or the closed amortization period – would alter the numerical calculations throughout the analysis but would be unlikely to impact the key messages of the study.

Q: What is the typical projection period of an A-L Study?

A: Our analysis typically covers time horizons of up to 30 years. For pension/OPEB funds, we believe asset allocation decisions should be made with a long-term view, consistent with the fact that the assets support liabilities that have a very long-term time horizon. SPRS' contribution policy, as it stands today, is designed to move the plan to full funded status over a finite period of time. The policy's applicability after that point comes into question, and it introduces a fair amount of noise into our analysis beyond the end of the amortization period. For this reason, we have truncated our projections in this Study to align more closely with the end of SPRS' closed amortization period.

Q: Do the asset class return assumptions used in the Study represent asset class returns that are available in the market today?

A: Not necessarily. For A-L Studies, we are projecting the behavior of assets and liabilities over long-term time horizons; as such, we use our longest-term (i.e., 30 year) assumed rates of return for the capital markets. Current market conditions and valuations will impact our long-term return projections, but so will our view on long-term fair value for factors such as interest rates, credit spreads, and equity market valuation.

Q: How often should an A-L study be done?

A: We typically suggest conducting asset-liability studies every three-to-five years depending on client specifics, or more frequently should circumstances dictate. (Such circumstances might include material changes to the fund's liability profile or contribution policy.) We also work with clients that prefer to revisit this analysis more frequently.

Q: What is an asset hurdle rate?

A: An asset hurdle rate is the growth needed from the assets, through both contributions and investment returns, to keep pace with the growth of the liability. It is calculated as the liability growth rate divided by the funded ratio.

Q: What is a liability growth rate?

A: Liability growth rate is the projected growth of the liability over the coming year as measured by the sum of the normal cost (i.e., new benefit accruals) and interest/discount cost (i.e., one year of discounting).

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Q: What is a funded ratio?

A: A Plan's funded ratio represents the value of plan assets (either the market value or actuarial value; the latter incorporates smoothing techniques) divided by the projected value of plan liabilities. A plan's funded ratio is an important metric, but it tells only a portion of the story. Of equal, or perhaps greater, importance to a pension/OPEB plan's financial health and long-term viability is the plan sponsor's willingness and ability to support future funding obligations.

Q: What are 'return-seeking' assets and 'risk-reducing' assets?

A: In general terms, our A-L Studies are designed to address two asset allocation-related questions: 1) What is an appropriate level of investment risk for a pension/OPEB plan, given its liability profile, and 2) what is the most optimal way to take that risk? Question 2) could be addressed without considering plan liabilities in a separate Asset Allocation Study, but since questions 1) and 2) are related we typically address them both within the framework of an Asset-Liability Study.

Question 1) is really the crux of an A-L Study. In order to simplify the analyses that address this question, our A-L studies bucket asset classes into one of two categories: "risk-reducing" – most typically cash and high-quality fixed income, and "return-seeking" – virtually all other classes of assets. We attempt to identify the most appropriate level of investment risk for a plan sponsor to assume by dialing the return-seeking and risk-reducing allocations up and down proportionally to illustrate risk-reward tradeoffs. Once we arrive at the most appropriate level of investment risk for the portfolio, the mix of underlying asset classes can be refined, and an asset allocation policy can be set that assigns target weightings to each individual asset class that is part of either the return-seeking or risk-reducing bucket.

Q: What if SPRS put all of its portfolio in return-seeking assets?

A: Such a policy would come under intense scrutiny in a down market and is likely not sustainable. It could also lead to liquidity challenges. If such an asset allocation policy were adopted and then changed under the pressure of a down market, it could very well result in an increase in future contributions relative to the current asset allocation policy.

Q: What if SPRS put all of its portfolio in risk-reducing assets?

A: As investment returns are one key component of closing the existing funding shortfall, dialing back risk in the portfolio will correspondingly increase the contributions that ultimately need to be made to the plan.

Q: So what is the right asset allocation policy for SPRS, based on the results of this Study?

A: If only it were that simple! A-L Studies are not necessarily prescriptive, and unfortunately rarely point to an obvious "right" answer. What we can say based on this Study, however, is:

1) *SPRS needs to take a fair amount of investment risk, given the nature of the plan's liabilities.* SPRS is currently underfunded (≈48% as of 9/30/2021), and its current contribution policy forces full funding at the end of its closed amortization period. This contribution policy results in a pretty heavy projected future contribution burden. Meaningfully reducing the level of investment risk would only add to this burden.

2) *Further increasing investment risk has diminishing marginal benefits.* The current target allocation (i.e., 87.5% in return-seeking assets) places a heavy emphasis on seeking high returns. Increasing this allocation further would lead to reduced returns per unit of risk assumed and would also lead to increasingly dire outcomes during market corrections. The latter could have implications for liquidity

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and the System's ability to make benefit payments under downside market scenarios.

3) *SPRS' Current & Alternative Policies generally align well with our best thinking for portfolio construction.* The Current & Alternative Policies are well constructed and efficient. There are no obvious opportunities for SPRS to earn better returns at the current risk level or earn the current level of returns with less risk.

4) The Alternative policy has appeal for the following reasons:

- Better liquidity to support increasing net outflows in the coming years.
- Better alignment between the discount rate (i.e., what the plan assets are *assumed to earn*) and what the assets are *expected to earn* under the **base case** scenario.
- Better performance in a **downside** scenario.

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Asset-Liability Study Overview

Michigan State Police Retiree Health Benefits (SPRS) – OPEB

January 2023

To protect the confidential and proprietary information included in this material, it may not be disclosed or provided to any third parties without the approval of Aon.

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- Asset-Liability Projection Analysis
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1

Executive Summary

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** and how they interact

When?

- Aon suggests conducting asset-liability studies every **3 to 5 years** depending on client specifics, or more frequently should circumstances dictate

How?

- **Identify future trends** in the financial health of the fund based on economic uncertainties that may not be evident from an actuarial valuation

Asset-Liability Study
Key Topics

Mix of Return-Seeking vs. Risk-Reducing Assets

Liquidity

Funding Interaction

Asset-Liability Study
Summary and Conclusions

Mix of Return-Seeking vs. Risk-Reducing Assets

- Plan is currently underfunded, expected to become fully funded by 2033
- Current portfolio is well-constructed with a high likelihood of meeting/exceeding the actuarial assumed rate of return
- Consider lower risk portfolios given funded status trajectory

Liquidity

- Net outflow is projected to increase over the next few decades
- Consider a slight increase to liquid assets

Funding Interaction

- Funding policy and expected returns provide buffers that mitigate contribution volatility

Asset-Liability Study
Key Observations

Current State Overview

- The SPRS OPEB plan is currently underfunded and the gap will be filled by a combination of 1) plan contributions and 2) investment returns
- Both the pension and OPEB plans are assumed to increasingly become more cash flow negative with each passing decade

Portfolio Analysis

- The current return-seeking asset portfolio is well-diversified
- Returns (**8.16%**[1]) are expected to outpace with the actuarial assumed rate of return (currently 6.25% decreasing to a floor of 6.00% based on the Dedicated Gains Policy)
- Over a 30-year timeframe, SPRS would be assumed to surpass a 6.00% return hurdle ~81% of the time

Asset-Liability Analysis

- The funded ratio is expected to increase over time, attain full funding (by FYE 2033), and become overfunded thereafter
- Advancing contributions and creating buffers, insulating negative events, are reasons why short-term volatility may appear less risky in the lead-up to full funding

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.

Asset-Liability Study

Contribution Policy Impacts the Projected Financials

Michigan SPRS' OPEB contribution policy is unique and has these three (3) key characteristics:

Floor Provision

- The floor provisions serve to advance funding in good scenarios, building a buffer to be used to offset future increases
  - In good times, the contributions will not decrease until full funding
  - In bad times, the contributions will increase and re-set the floor for future years

Closed Amortization

- The closed amortization policy forces full funding by a specific date
  - By itself, volatility will increase in the future as that period moves to immediate recognition
  - Along the way, volatility is subdued based on a buffer that has accumulated under each specific path

Banking Excess Returns

- Excess returns greater than the actuarial rate will build a buffer which can be used to offset future contribution increases

Investment Strategies Studied

Alternative Policy Is More Liquid Than Current Policy

Asset Class	Current Policy (87.5% R-S)	Alternative Policy (85% R-S)	Difference	Current Rebalancing Ranges	Alternative Rebalancing Ranges
Equity					
- U.S. Equity	25.0%	25.0%	--	17% - 32%	17% - 32%
- International Equity	15.0%	15.0%	--	12% - 22%	12% - 22%
- Private Equity	16.0%	16.0%	--	13% - 25%	13% - 27%
- Subtotal	56.0%	56.0%	--		
Absolute Return / Liquid Alternatives					
- Subtotal	9.0%	9.0%	--	5% - 11%	5% - 11%
Real Return / Opportunistic					
- Subtotal	12.5%	10.0%	(2.5%)	8% - 18%	8% - 18%
Real Estate & Infrastructure					
- Subtotal	10.0%	10.0%	--	8% - 18%	8% - 18%
Risk-Reducing					
- Short-Term Fixed Income (Cash)	2.0%	2.0%	--	1% - 8%	1% - 8%
- Long-Term Fixed Income (Core Fixed Income)	10.5%	13.0%	+2.5%	8% - 18%	8% - 18%
- Subtotal	12.5%	15.0%	--		
Expected Return[1]	**8.16%**	**8.04%**	**(0.12%)**		
Expected Risk[1]	13.84%	13.50%	(0.34%)		
Sharpe Ratio	0.38	0.38	--		
Probability of Meeting/Exceeding 6.00%	**81%**	**80%**	**(1.0%)**		
1-Year Downside Return (2 Standard Deviations)	**-18.6%**	**-18.1%**	**+0.5%**		
Illiquid Assets	**47.1%**	**44.6%**	**(2.5%)**		

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.

Key Takeaways:

- Modest reduction in forecasted return; more meaningful reduction in forecasted volatility
  - Similar Sharpe Ratio
  - Better one-year downside return
- Over a 30-year timeframe, the alternative policy would be assumed to surpass its return hurdle 80% of the time
- Increase in plan liquidity in response to forecasted cash flow needs as well as adding tactical flexibility
- Compared to peers, Michigan is at the lower end of fixed income allocations

2

Analysis

- Current State Asset-Liability Profile
- Portfolio Analysis
- Asset-Liability Projection Analysis
- Aggregate Net Cash Flow Analysis

Current State Asset-Liability Profile

As of September 30, 2021

As of the most recent actuarial valuation reports (September 30, 2021), below is a high level comparison of the State of Michigan's pension / OPEB plans:

	(In $ millions)					
Pension	**Discount Rate**	**Market Value of Assets**	**Actuarial Liability**	**Funded Ratio**	**Liability Growth Rate**	**Asset Hurdle Rate**
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-Total Pension		$80,023.8	$118,642.3	67.45%	6.97%	10.33%
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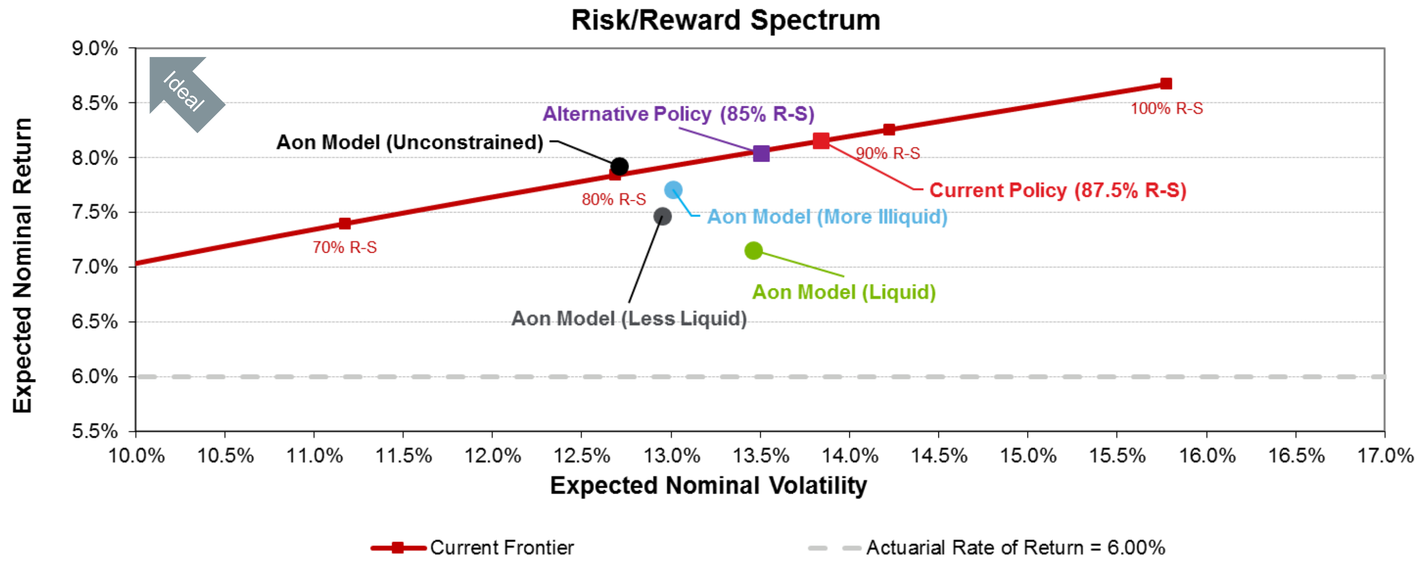
-Michigan Public Schools Employees' Retiree Health Benefits	6.00%	$10,742.2	$12,376.9	86.79%	6.61%	7.61%
-Michigan State Employees' Retiree Health Benefits	6.20%	$5,082.3	$8,814.6	57.66%	7.26%	12.58%
-Michigan State Police Retiree Health Benefits	6.25%	$372.9	$780.1	47.80%	7.46%	15.61%
-Michigan Judges' Retiree Health Benefits	6.00%	$11.8	$8.1	145.98%	8.99%	6.16%
-Total OPEB		$16,209.1	$21,979.8	73.75%	6.90%	9.35%

Portfolio Analysis
Risk/Reward Spectrum



Notes:

- **Red** Square: "Current Policy" = Michigan's current mix of Risk-Reducing assets (12.5%) and Return-Seeking assets (87.5%)
  - **Red** Line "Current Frontier" = Michigan's Current Policy, scaled to different risk levels (Risk-Reducing assets [FI and cash] and Return-Seeking assets [all other assets] scaled up and down proportionally)
- **Purple** Square: "Alternative Policy" = Michigan's Current Policy with a 2.5% adjustment from Real Return / Opportunistic to Long Term Fixed Income
- Circles (**Green**, **Blue**, **Gray**, **Black**) = "Aon Model Portfolios" – i.e., Aon's starting point for Asset Allocation discussions with clients
  - "Liquid" is designed for clients with a low level of resources / low tolerance for portfolio complexity;
  - "Unconstrained" is for clients at the other end of the resource / complexity spectrum

Key Takeaways:

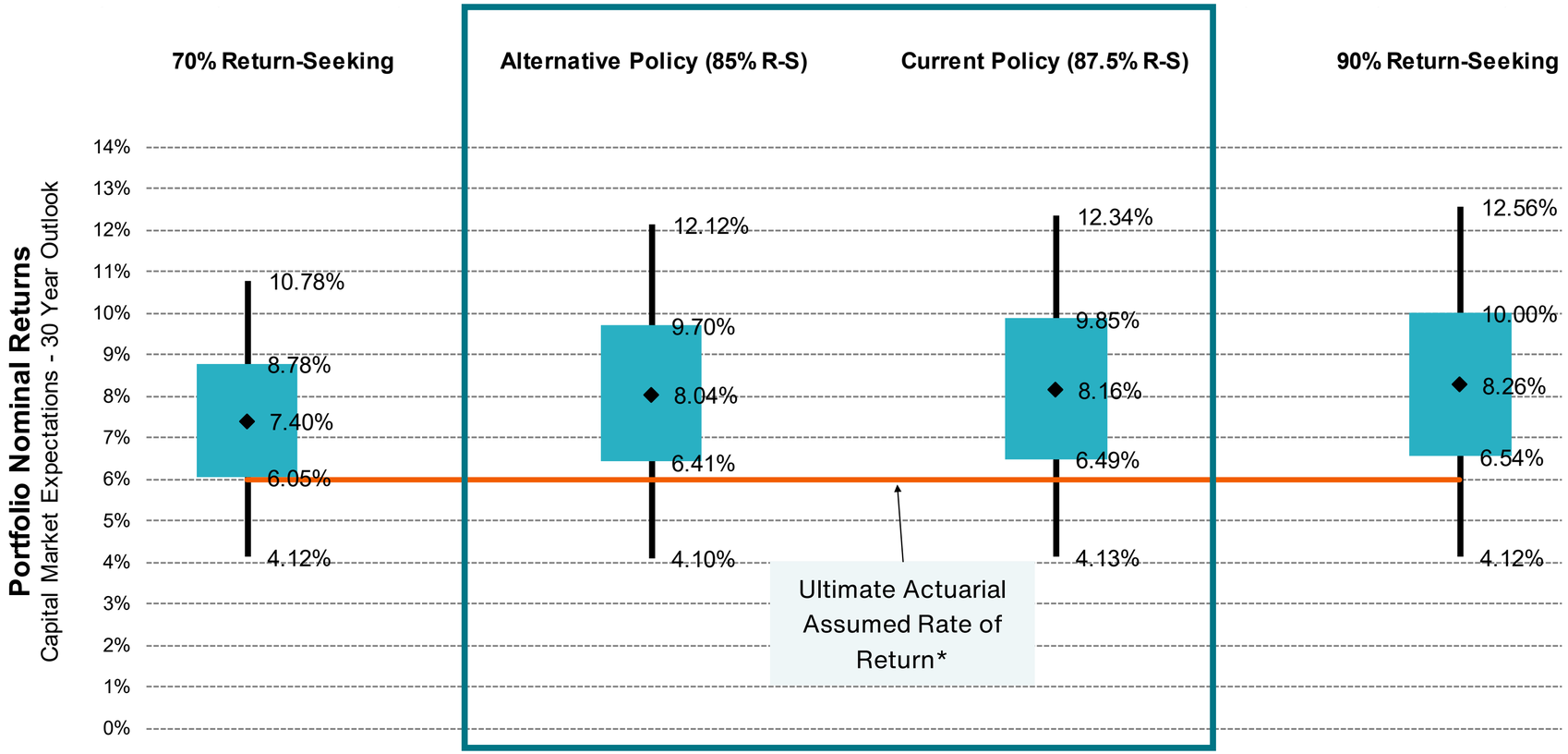
- Current & Alternative Policies have a higher long-term return forecast than any Aon Model Portfolio
- Current Frontier is more efficient than three of the four Aon Model Portfolios
- Current & Alternative Policies model as more volatile (i.e., has a higher standard deviation of forecasted investment returns) than the Aon Model portfolios

	Expected Nominal Return[1]	Expected Nominal Volatility	Sharpe Ratio
Current Policy (87.5% R-S)	8.16%	13.84%	0.38
Alternative Policy (85% R-S)	8.04%	13.50%	0.38
Aon Model (Liquid)	7.16%	13.46%	0.32
Aon Model (Less Liquid)	7.47%	12.95%	0.35
Aon Model (More Illiquid)	7.71%	13.01%	0.37
Aon Model (Unconstrained)	7.92%	12.71%	0.40

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.

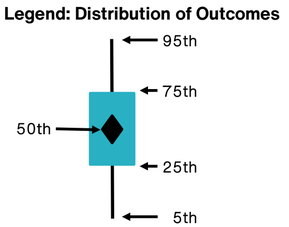
Portfolio Analysis

Range of Nominal Returns[1]



Key Takeaways:

- Median expected returns for policies greater than 50% return-seeking assets are projected to exceed the ultimate actuarial assumed rate of return (6.00%)
- Current Policy has an 81% likelihood of surpassing the 6.00% ultimate actuarial assumed rate of return

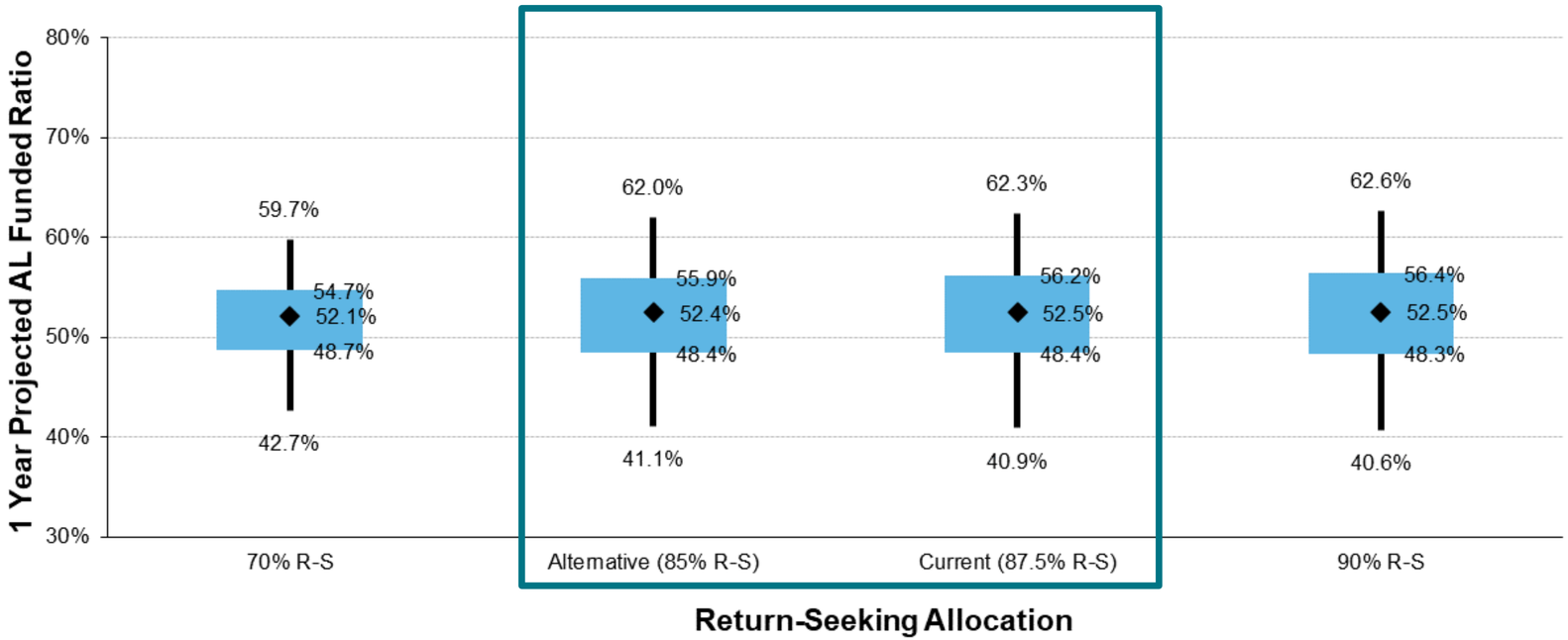


[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.

* State Police Retire Health System remains subject to the Dedicated Gains Policy with a current actuarial rate of return of 6.20% and an ultimate rate of 6.00%

Asset-Liability Projection Analysis

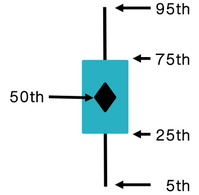
Short-Term Funded Ratio (1 Year) | Market Value of Assets / Actuarial Liability



Key Takeaways:

- Higher risk portfolios are projected to have both more upside and downside potential over a short time horizon (1 year in this exhibit)
- Similarly, lower risk portfolios will have a narrower range of potential outcomes

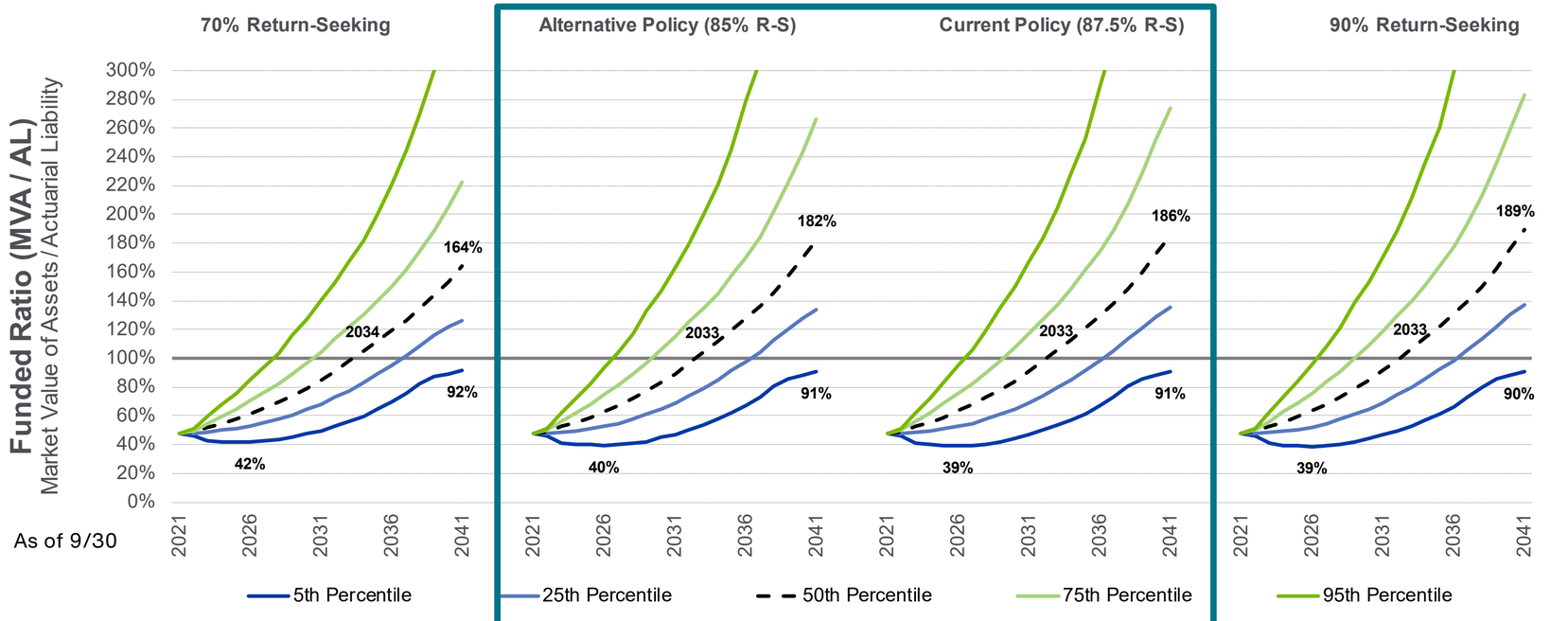
Legend: Distribution of Outcomes



* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Asset-Liability Projection Analysis

Long-Term Funded Ratio (20 Years) | Market Value of Assets / Actuarial Liability



Strategy	70% Return-Seeking			Alternative Policy (85% R-S)			Current Policy (87.5% R-S)			90% Return-Seeking		
Year	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041
5th Percentile	42%	50%	92%	40%	47%	91%	39%	47%	91%	39%	47%	90%
25th Percentile	53%	68%	126%	52%	69%	134%	52%	69%	135%	52%	69%	137%
50th Percentile	61%	85%	164%	63%	89%	182%	63%	90%	186%	64%	91%	189%
75th Percentile	70%	105%	>200%	74%	115%	>200%	75%	117%	>200%	76%	119%	>200%
95th Percentile	85%	140%	>200%	93%	163%	>200%	95%	167%	>200%	96%	170%	>200%
Probability > 100%	<1%	31%	90%	3%	40%	91%	4%	41%	91%	4%	42%	91%

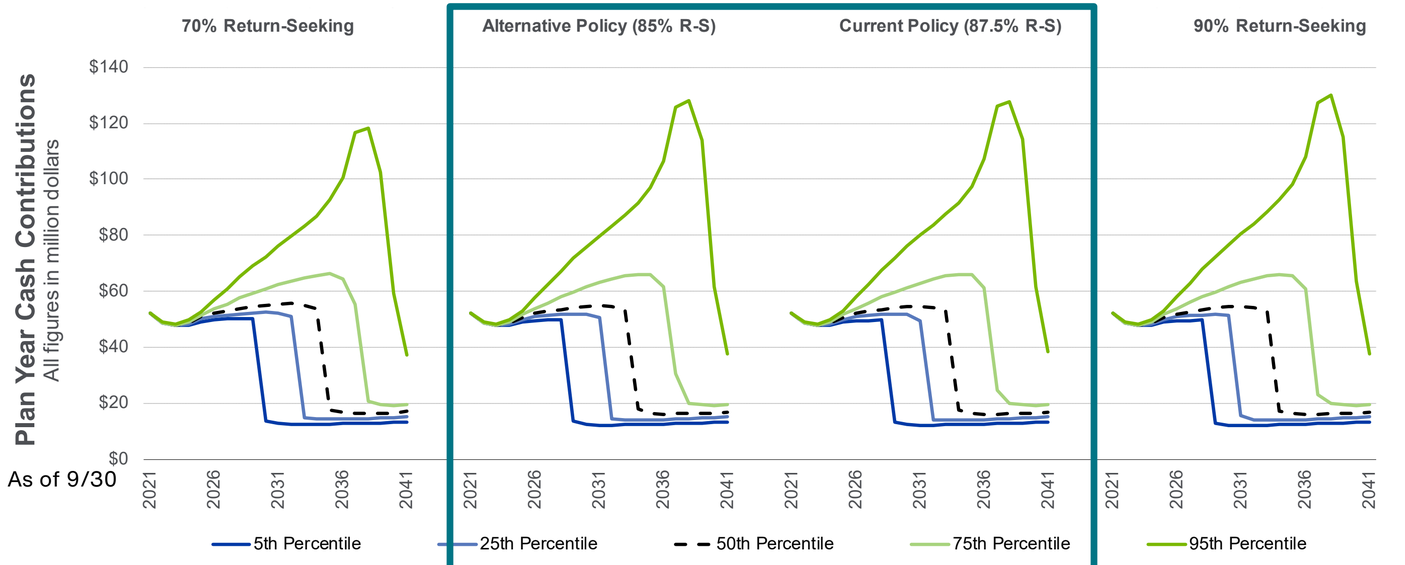
* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Key Takeaways:

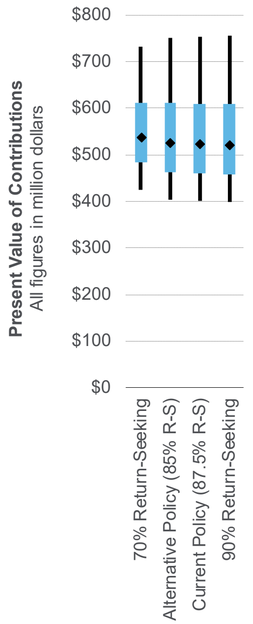
- Under the Current Policy (87.5% R-S), the funded ratio is expected to move towards full funding by FYE 2033 in the central expectation (50th percentile outcome)
- Contribution policy is projected to close the funding shortfall across investment strategies modeled
- Higher return-seeking allocations will increase the central trendline of funded ratio faster, albeit with more volatility

Asset-Liability Projection Analysis

Total Contributions Amounts (Employer + Employee)

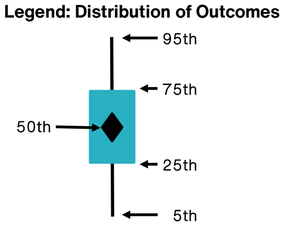


Strategy	70% Return-Seeking			Alternative Policy (85% R-S)			Current Policy (87.5% R-S)			90% Return-Seeking		
Year	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041
5th Percentile	$50	$13	$13	$49	$12	$13	$49	$12	$13	$49	$12	$13
25th Percentile	$51	$52	$15	$51	$51	$15	$51	$50	$15	$51	$16	$15
50th Percentile	$52	$55	$17	$52	$55	$17	$52	$55	$17	$52	$54	$17
75th Percentile	$54	$62	$20	$54	$63	$20	$54	$63	$20	$54	$63	$20
95th Percentile	$57	$76	$37	$58	$80	$38	$58	$80	$39	$58	$80	$38



Key Takeaways:

- The higher the allocation to return-seeking assets, the lower the present value of future contributions will be on average but the greater the variability in contributions
- Current & Alternative Policies have similar contribution projections



* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Asset-Liability Projection Analysis

Summary of Results

R-S%	30Y Expected Return[1]	30Y Nominal Volatility	Sharpe Ratio	1Y Return (2 STD Down)	20-year Economic Cost (in $ Millions)		20-year Present Value of Contributions (in $ Millions)		20-year Ending Funded Ratio (MVA / AL)	
					Expected[2]	Downside[3]	Expected[2]	Downside[3]	Expected[2]	Downside[4]
Current Policy (87.5% R-S)	8.16%	13.84%	0.38	-18.6%	$422.6	$698.5	$523.3	$752.7	186%	91%
Alternative Policy (85% R-S)	8.04%	13.50%	0.38	-18.1%	$428.7	$697.6	$524.7	$751.2	182%	91%
Current Frontier of Results										
70.0%	7.40%	11.17%	0.40	-14.4%	$458.8	$682.5	$537.8	$731.9	164%	92%
72.5%	7.51%	11.55%	0.40	-15.0%	$453.2	$685.1	$535.4	$733.9	167%	91%
75.0%	7.62%	11.93%	0.40	-15.6%	$447.7	$687.1	$533.3	$737.2	170%	91%
77.5%	7.73%	12.31%	0.39	-16.2%	$442.9	$688.7	$531.1	$740.0	173%	91%
80.0%	7.84%	12.69%	0.39	-16.8%	$438.2	$690.3	$528.7	$743.2	176%	91%
82.5%	7.95%	13.07%	0.39	-17.4%	$433.2	$693.1	$526.1	$745.9	179%	91%
85.0%	8.05%	13.45%	0.38	-18.0%	$428.6	$695.7	$524.9	$749.3	183%	91%
87.5%	8.16%	13.84%	0.38	-18.6%	$422.6	$698.5	$523.3	$752.7	186%	91%
90.0%	8.26%	14.22%	0.38	-19.3%	$417.1	$701.7	$520.1	$755.4	189%	90%

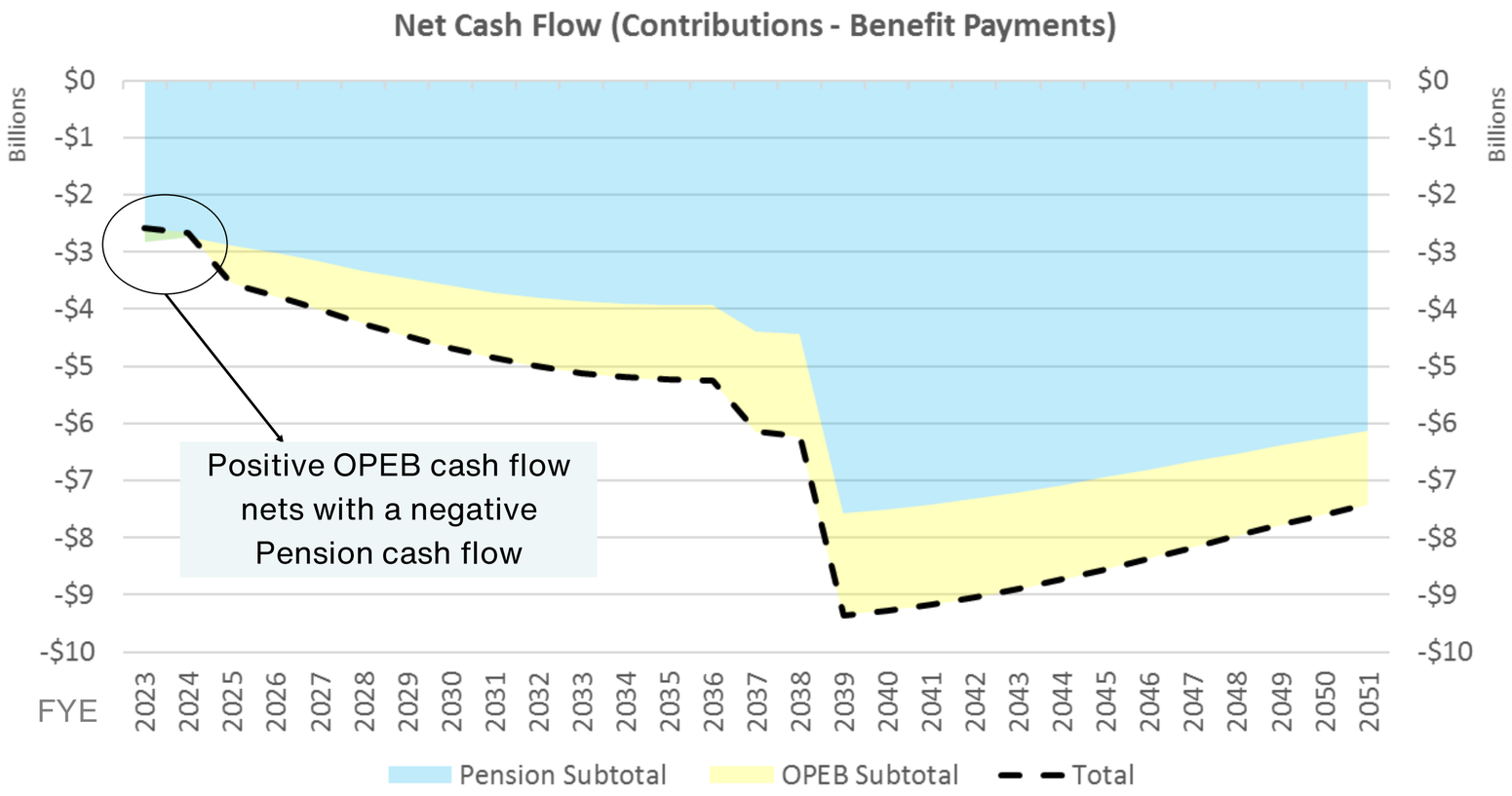
[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.
[2] Expected = 50th percentile outcome or central expectation across all 5,000 simulations
[3] Downside = 95th percentile outcome across all 5,000 simulations
[4] Downside = 5th percentile outcome across all 5,000 simulations

Key Takeaways:

- All else equal, we believe SPRS OPEB would benefit from reducing its investment risk posture, at least at the margin
- The alternative policy is projected to result in:
  - Lower expected returns, nominal volatility, downside (95th percentile) contribution amounts, and more favorable one year downside return.
  - Similar Sharpe Ratio (i.e., same efficiency) and expected attainment of full funding
  - Slightly higher expected (50th percentile) contribution amounts

Aggregate Net Cash Flow Analysis

Michigan Is Projected to Have a Total Net Cash Outflow, Driven By the Pension Plans



Key Observations:

- Baseline actuarial data provided by GRS
- Aggregate pension plans are shown in blue; aggregate OPEB plans in yellow
- Michigan is projected to have an aggregate baseline of negative cash flow with more going out in benefit payments than coming in via contributions
- Closed amortization policy drives the sharp change mid-projection period
- Both the aggregate pension and aggregate OPEB plans are assumed to increasingly become more cash flow negative with each passing decade

3

Summary and Conclusions

Summary and Conclusions

Mix of Return-Seeking vs. Risk-Reducing Assets

- Plan is currently underfunded, expected to become fully funded by 2033
- Current portfolio is well-constructed with a high likelihood of meeting/exceeding the actuarial assumed rate of return
- Consider lower risk portfolios given funded status trajectory

Liquidity

- Net outflow is projected to increase over the next few decades
- Consider a slight increase to liquid assets

Funding Interaction

- Funding policy and expected returns provide buffers that mitigate contribution volatility

4

Appendix

- Portfolio Analysis
- Peer Benchmarking
- Aggregate Liability Analysis
- Asset-Liability Projection Analysis
- Contribution Policy Impact on Asset-Liability Study
- Capital Market Assumptions

Portfolio Analysis | Spectrum of Our Model Portfolios

Reflects Our Best Ideas for a Typical Pension Plan

Aon's Model Portfolios reflect Aon's best ideas for a typical total return defined benefit plan across a range of circumstances noted below

- Intended as a ***starting point*** for asset allocation analysis and decision-making and to be customized based on client-specific needs and circumstances

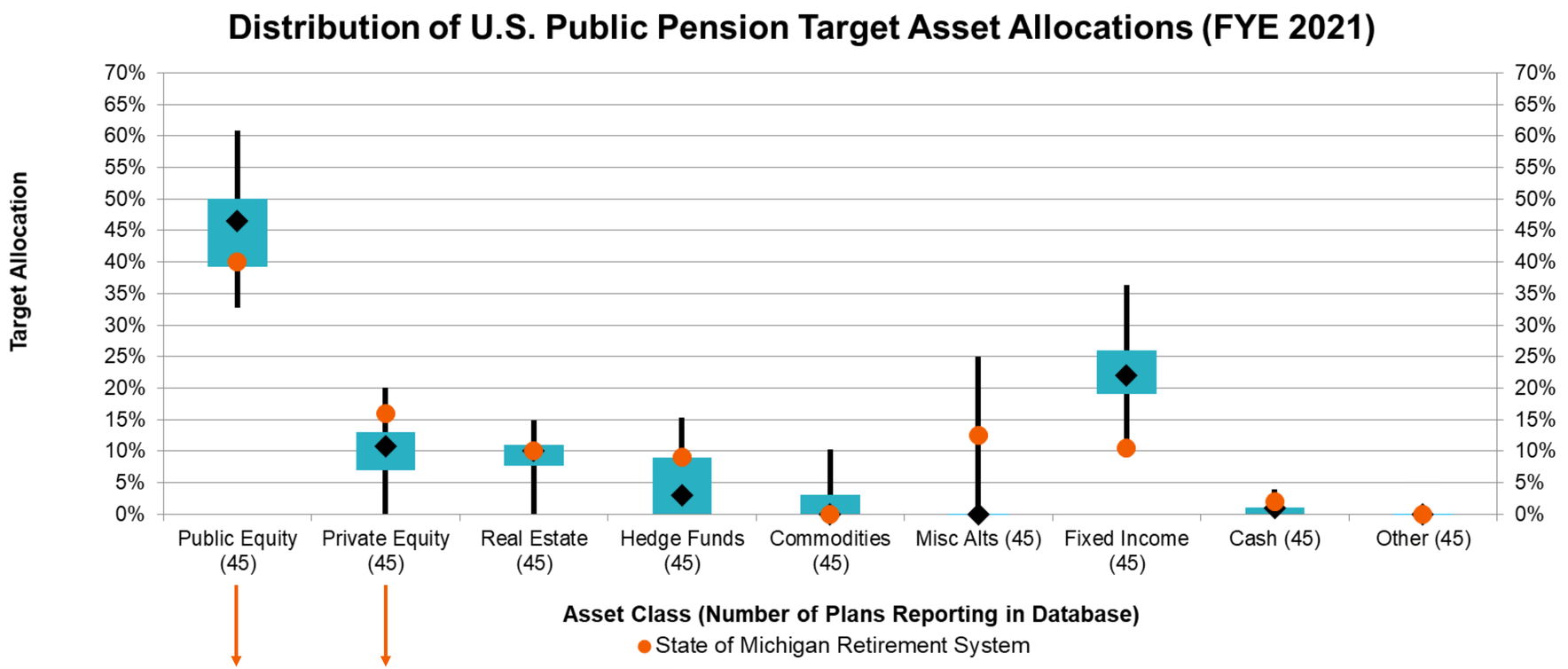
	Liquid	Less Liquid	More Illiquid	Unconstrained
Complexity	Simple			Complex
Costs	Low Cost			Higher Cost
Resources	Light Resources			Deep Resources
Governance	Modest Governance			Strong Governance
Liquidity	More Liquid			Less Liquid

- As a general statement, moving from left-to-right on the above spectrum increases both investment portfolio return potential and risk-adjusted return potential, based on our capital markets modelling
  - It also increases the reliance on "alpha" (manager skill) and reduces the emphasis on market "beta" (market risk premiums); alpha is not guaranteed

AON

Peer Benchmarking

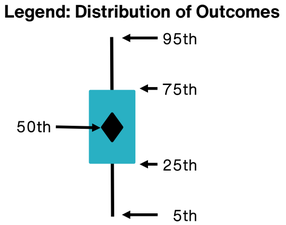
Distribution of U.S. Public Pension Target Asset Allocations (Assets > $25B)[1]



	Public Equity	Private Equity	Total Equity
Michigan	40%	16%	56%
Public Peers	46%	11%	57%
Difference	(6%)	+5%	(1%)

Key Observations:

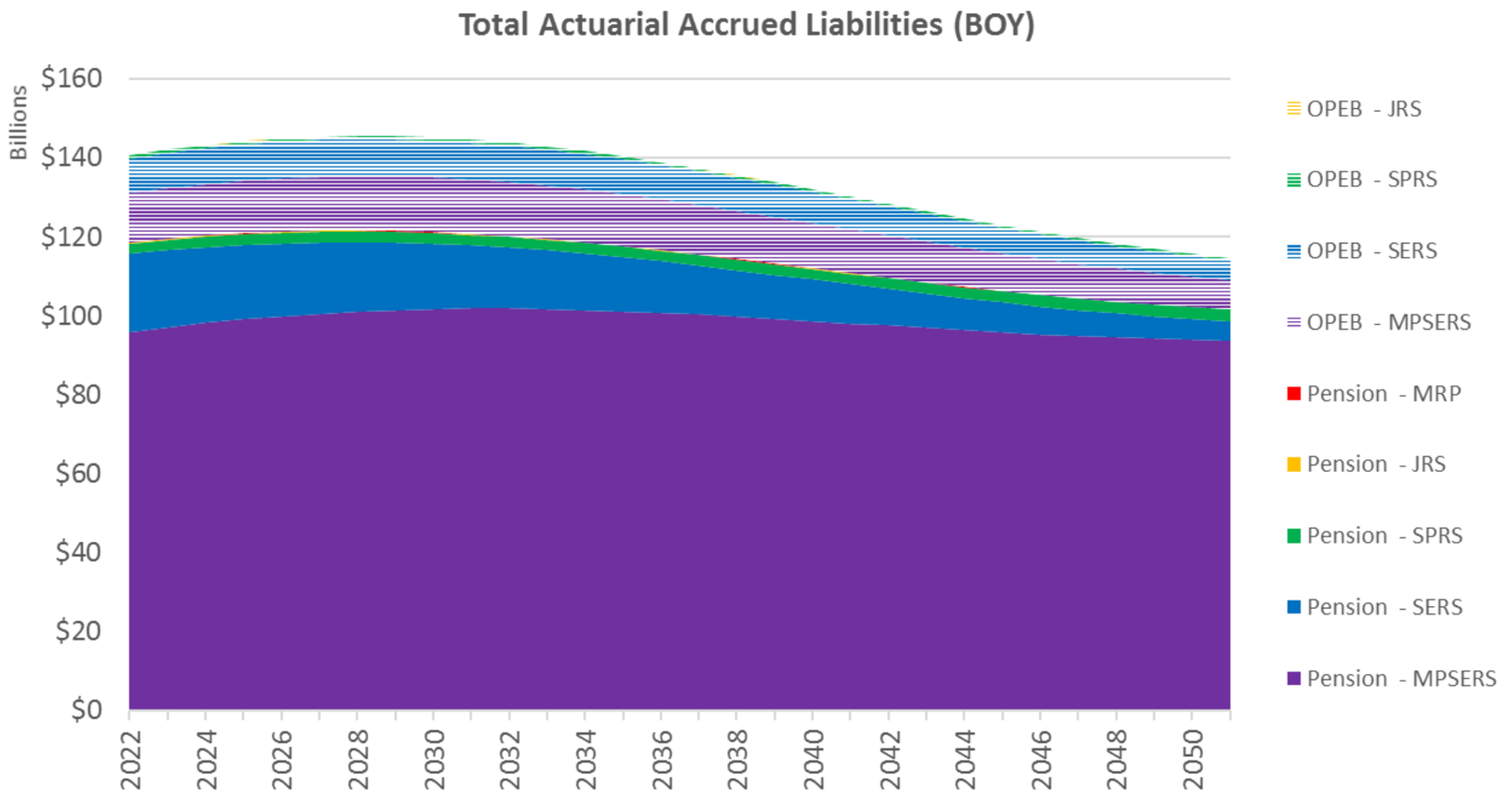
- Michigan's total equity allocation (public + private) is similar to public plans with greater than $25 billion in assets
- Michigan's fixed income allocation is at the 5th percentile relative to peers with $25 billion in assets



Source: Public Plans Data (publicplansdata.org) as of July 2022
[1] Peers defined as public funds published within publicplansdata.org as of July 2022; Number of plans per year are shown in parentheses
* Data point references the Michigan Public Schools Retirement System for comparison purposes

Aggregate Liability Analysis

Based on GRS' Baseline Projections | Total Liability Peaks in Fiscal Year Ending 2028

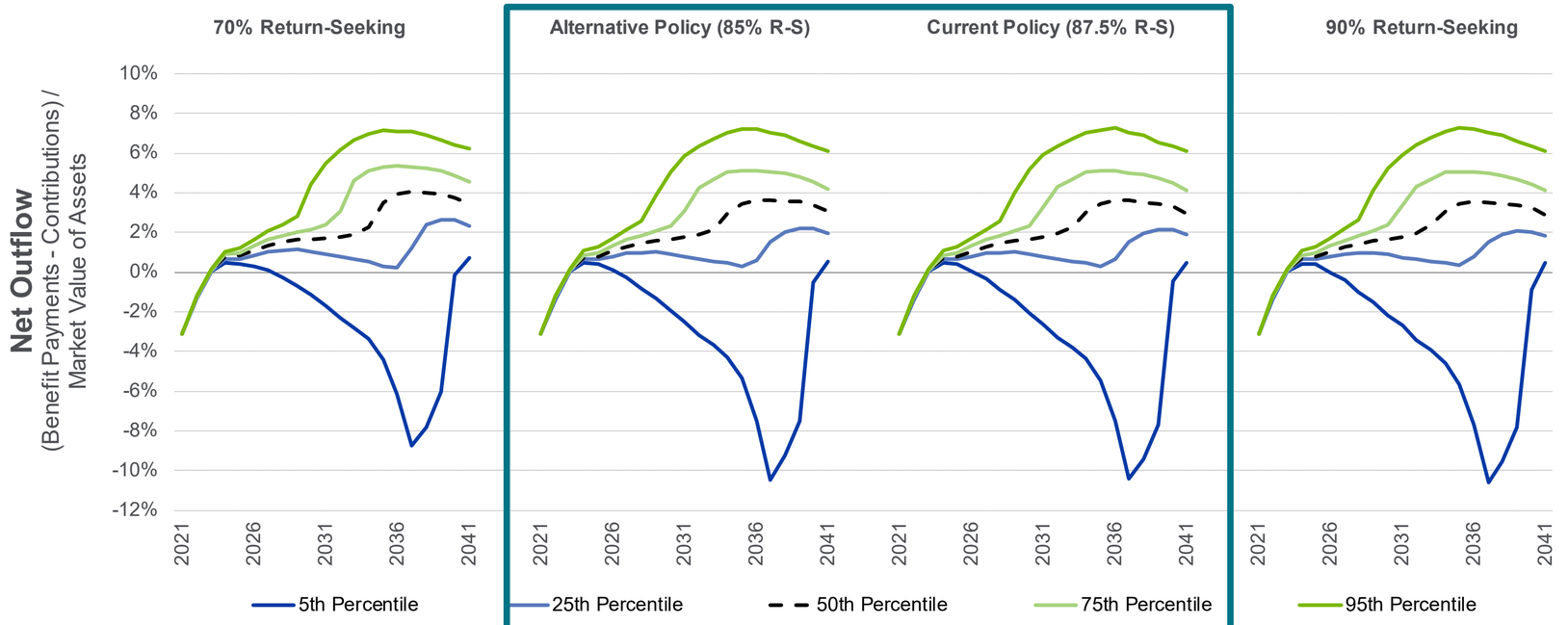


Key Observations:

- Individual systems are color-coded; pension plans are shown in solid colors with OPEB plans in stripes
- Based on GRS' projections, the aggregate liability reaches its peak in Fiscal Year Ending 2028

Asset-Liability Projection Analysis

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



Strategy	70% Return-Seeking			Alternative Policy (85% R-S)			Current Policy (87.5% R-S)			90% Return-Seeking		
Year	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041
5th Percentile	0.3%	-1.7%	0.7%	0.1%	-2.5%	0.5%	0.1%	-2.6%	0.5%	0.0%	-2.7%	0.5%
25th Percentile	0.9%	0.9%	2.4%	0.8%	0.8%	1.9%	0.8%	0.8%	1.9%	0.8%	0.7%	1.8%
50th Percentile	1.1%	1.7%	3.4%	1.1%	1.8%	3.0%	1.0%	1.8%	3.0%	1.0%	1.8%	2.9%
75th Percentile	1.3%	2.4%	4.5%	1.3%	3.0%	4.2%	1.3%	3.2%	4.1%	1.3%	3.4%	4.1%
95th Percentile	1.7%	5.5%	6.2%	1.7%	5.9%	6.1%	1.7%	5.9%	6.1%	1.7%	5.9%	6.1%
Probability > 10%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Key Takeaways:

- The Plan is assumed to have net outflows increase over the projection period
- Net outflows are expected to increase to the 1-4% range over the projection period
- Net outflows of 10%+ can put stress on fund liquidity over time; however, it is not likely over the projection period

Contribution Policy Impact on Asset-Liability Study

Overview

- Michigan's asset-liability study results are heavily influenced by its contribution policy, specifically how the following pieces interact:
  - Floor provision
  - Investment strategy expecting a return greater than the actuarial assumptions
  - Closed amortization

- In their individual silo, each provision is also used to some degree by other public pension plans; however, in our experience, their combination is unique to Michigan

Contribution Policy Impact on Asset-Liability Study

Floor Provision

- The following plans have a floor provision on their contribution policy, related to either the normal cost or amortization component of the calculations:
  - MPSERS, SPRS

- The floor provisions serve to advance funding in good scenarios, building a buffer to be used to offset future increases
  - In good times, the contributions will not decrease until full funding
  - In bad times, the contributions will increase and re-set the floor for future years

- A floor provision is utilized in other public pension plans:
  - Nebraska Public Employees Retirement System; San Diego City Employees' Retirement System

Contribution Policy Impact on Asset-Liability Study

Banking Excess Returns

- Based on results from Aon's 6/30/2022 capital market assumptions, the Michigan portfolio has a 30-year expected return assumption of 8.16%

- Over a 30-year timeframe, Michigan would be assumed to surpass its actuarial assumed rate of return (6.00%) in ~81% of scenarios

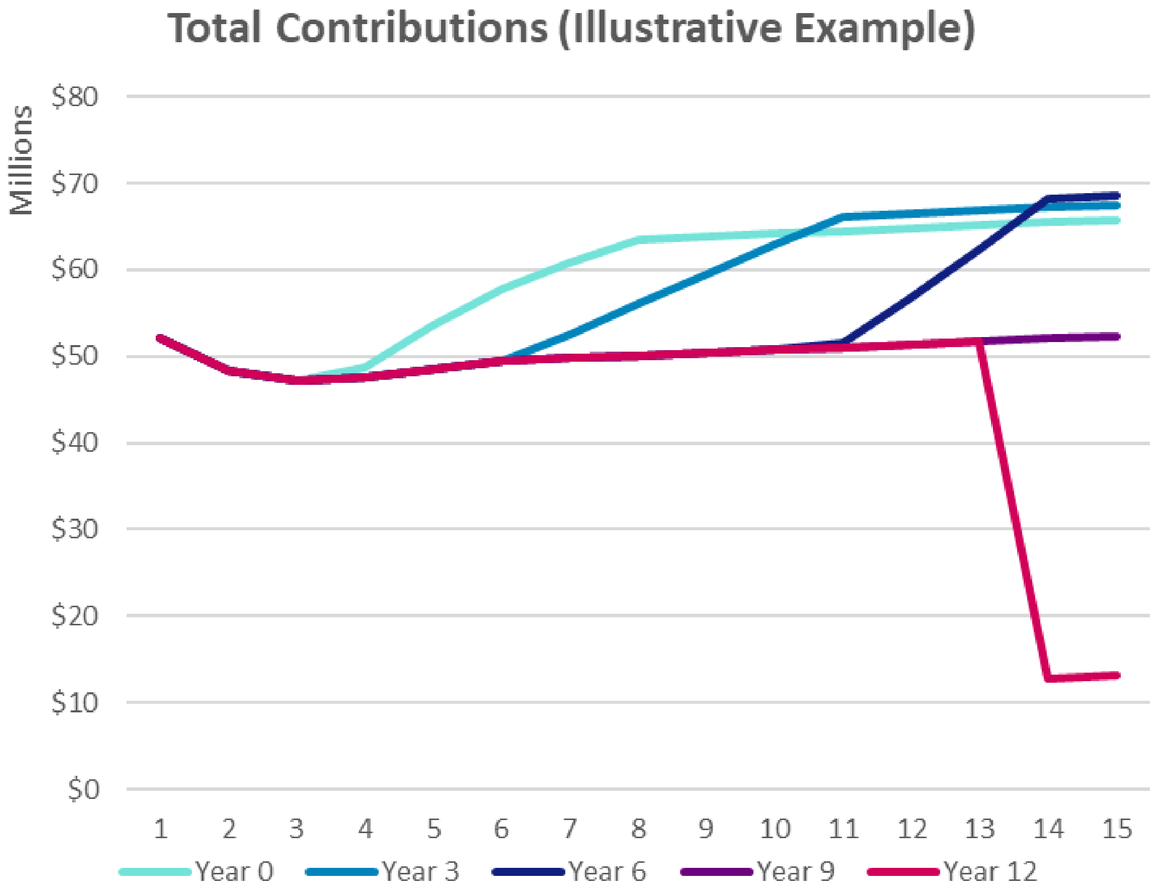
- Similar to the floor provision, excess returns over the actuarial rate will build a buffer to be used to offset future increases

Percentile	Current Policy (87.5% R-S)
5th	4.13%
25th	6.49%
50th	**8.16%**
75th	9.85%
95th	12.34%

Contribution Policy Impact on Asset-Liability Study

Closed Amortization

- The closed amortization policy forces full funding by a specific date; by itself, volatility will increase in the future as that period moves to immediate recognition
- Along the way, volatility is subdued based on the buffer (from the contribution floor and excess asset returns) that has accumulated under each specific path
- The example to the right assumes a 15 year geometric return of 6.00% (the actuarial assumption) with -20% negative shock applied at various points in time (resulting in returns of 8.15% in the other 14 years):
  - The earlier the shock occurs, the more contributions will increase (see shocks in Years 0, 3, and 6)
  - The later the shock occurs, the more likely the Plan has a large enough buffer that contributions will not correspondingly increase (see shock in Years 9 and 12)



Contribution Policy Impact on Asset-Liability Study

Key Findings

- The combination of the floor provision and asset returns expected to be greater than the actuarial assumption is expected to...
  - Keep contributions steady until full funding, advancing contributions rather than realizing any near-term savings
  - Build up a buffer or reserve which can be tapped into in adverse markets

- The closed amortization policy will add volatility to the plan contributions as the time to immediate recognition comes closer
  - That volatility could be dampened depending on the path taken and how much of a buffer has accumulated leading up to adverse market conditions

- **Advancing contributions and creating buffers to insulate negative events are some reasons why a riskier portfolio in our asset-liability modeling may not appear noticeably riskier in the lead-up to full funding**

Portfolio Analysis

Aon Model Portfolios vs. Current SPRS OPEB Policy

Asset Class	Current Policy (87.5% R-S)	Aon Model (Liquid)	Aon Model (Less Liquid)	Aon Model (More Illiquid)	Aon Model (Unconstrained)
Equity					
- Public Equity	40.0%	65.6%	54.7%	49.2%	38.3%
- Private Equity	22.3%[2]	0.0%	5.5%	10.9%	16.4%
- Subtotal	62.3%	65.6%	60.2%	60.2%	54.7%
Liquid Alternatives					
- Subtotal	5.9%	0.0%	5.5%	8.2%	8.2%
Return-Seeking Fixed Income					
- Multi-Asset Credit	6.3%	8.2%	8.2%	5.5%	5.5%
- Private Debt	3.2%	0.0%	0.0%	2.7%	5.5%
- Subtotal	9.4%	8.2%	8.2%	8.2%	10.9%
Real Assets					
- Real Estate (Core)	1.3%	13.7%	8.2%	5.5%	5.5%
- Real Estate (Non-Core)	6.8%	0.0%	2.7%	2.7%	4.1%
- REITs	0.4%	0.0%	0.0%	0.0%	0.0%
- Infrastructure	1.5%	0.0%	2.7%	2.7%	4.1%
- Subtotal	10.0%	13.7%	13.7%	10.9%	13.7%
Risk-Reducing					
- Cash	2.0%	2.0%	2.0%	2.0%	2.0%
- Core / Core Plus Fixed Income	10.5%	10.5%	10.5%	10.5%	10.5%
- Subtotal	12.5%	12.5%	12.5%	12.5%	12.5%
Expected Return[1]	**8.16%**	**7.16%**	**7.47%**	**7.71%**	**7.92%**
Expected Risk[1]	13.84%	13.46%	12.95%	13.01%	12.71%
Sharpe Ratio	0.38	0.32	0.35	0.37	0.40
1-Year Downside Return (2 Standard Deviations)	-18.6%	-18.9%	-17.7%	-17.5%	-16.8%
Illiquid Assets	47.1%	13.7%	24.6%	32.8%	43.8%

Key Takeaways:

- Current SPRS OPEB Policy generally compares favorably to the Aon Model Portfolios
- Current SPRS OPEB Policy's total equity exposure appears on the higher end of the Aon Model Portfolios
- Current SPRS OPEB Policy's higher exposure to equity risk results in higher forecasted total portfolio volatility
  - Also explains Current Policy's Sharpe Ratio being less than the Unconstrained Model

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.

[2] For modeling purposes, Michigan's 12.5% allocation to Real Return & Opportunistic assets is split 50/50 between Private Equity and Multi-Asset Credit

Percentages in table may not sum to 100% due to rounding

Capital Market Assumptions

Mapping of Current Target Asset Allocation

The Current Target Asset Allocation is modeled using our capital market assumptions as follows:

Target Asset Allocation as of June 30, 2022		
	Allocation %	**Capital Market Assumption Mapping**
Return-Seeking		
- U.S. Equity	25.0%	90% U.S. Large Cap / 10% U.S. Small Cap
- Private Equity	16.0%	Private Equity
- International Equity	15.0%	75% International Developed / 25% Emerging Markets
- Real Return / Opportunistic	12.5%	50% Private Equity / 50% Multi-Asset Credit
- Real Estate & Infrastructure	10.0%	68% Non-Core Real Estate / 12.75% Core Real Estate / 4.25% U.S. REITs / 15% Infrastructure
- Absolute Return	9.0%	65% Hedge Funds (Direct -- Median Manager) / 35% Private Debt Direct Lending
- Total	87.5%	
Risk-Reducing		
- Cash & Short Term Fixed Income	2.0%	Cash
- Long Term Fixed Income	10.5%	Core Fixed Income
- Total	12.5%	
Total	100.0%	

Our Capital Market Assumptions

As of June 30, 2022 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.8%	7.3%	17.5%
2	Small Cap U.S. Equity	5.3%	7.8%	23.5%
3	International Equity (Developed)	5.1%	7.6%	21.0%
4	Emerging Markets Equity	5.7%	8.2%	24.5%
	Fixed Income			
5	Cash (Gov't)	0.5%	2.9%	2.0%
6	Core Fixed Income	1.3%	3.7%	4.5%
7	Core Plus Fixed Income	1.7%	4.1%	5.0%
8	Multi-Asset Credit[2]	4.4%	6.9%	9.0%
	Alternatives			
9	Direct Hedge Funds[2,3]	3.5%	6.0%	9.5%
10	US REITs	3.9%	6.4%	19.0%
11	Core Real Estate	2.6%	5.1%	15.5%
12	Non-Core Real Estate	4.2%	6.7%	25.5%
13	Private Equity	7.6%	10.2%	25.5%
14	Infrastructure	5.2%	7.7%	15.0%
15	Closed-End Real Assets	5.5%	8.0%	16.0%
16	Private Debt	4.6%	7.1%	17.5%
	Inflation			
17	Inflation	0.0%	2.4%	2.0%

[1] Expected returns are using Aon Investments Q3 2022 30-Year 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.

[2] Alpha incorporated in Expected Nominal Return

[3] Represents diversified portfolio of Direct hedge fund investments.

Our Capital Market Assumptions

As of June 30, 2022

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Large Cap U.S. Equity	**1.00**	0.93	0.81	0.73	0.07	0.02	0.08	0.61	0.66	0.65	0.34	0.45	0.62	0.34	0.52	0.38	0.07
2	Small Cap U.S. Equity	0.93	**1.00**	0.75	0.68	0.06	0.02	0.07	0.57	0.62	0.61	0.32	0.43	0.60	0.34	0.50	0.36	0.07
3	International Equity (Developed)	0.81	0.75	**1.00**	0.76	0.03	0.01	0.07	0.62	0.56	0.54	0.34	0.44	0.56	0.31	0.50	0.38	0.10
4	Emerging Markets Equity	0.73	0.68	0.76	**1.00**	0.06	0.03	0.08	0.64	0.46	0.50	0.32	0.41	0.53	0.29	0.46	0.40	0.07
5	Cash (Gov't)	0.07	0.06	0.03	0.06	**1.00**	0.41	0.36	0.04	-0.03	0.07	0.13	0.12	0.07	0.11	0.14	-0.17	0.29
6	Core Fixed Income	0.02	0.02	0.01	0.03	0.41	**1.00**	0.98	0.25	0.04	0.02	0.05	0.04	0.03	0.05	0.05	0.07	-0.02
7	Core Plus Fixed Income	0.08	0.07	0.07	0.08	0.36	0.98	**1.00**	0.39	0.18	0.06	0.07	0.07	0.08	0.07	0.09	0.23	-0.02
8	Multi-Asset Credit	0.61	0.57	0.62	0.64	0.04	0.25	0.39	**1.00**	0.68	0.40	0.22	0.30	0.40	0.22	0.34	0.68	0.09
9	Direct Hedge Funds	0.66	0.62	0.56	0.46	-0.03	0.04	0.18	0.68	**1.00**	0.42	0.21	0.29	0.41	0.22	0.33	0.56	0.03
10	US REITs	0.65	0.61	0.54	0.50	0.07	0.02	0.06	0.40	0.42	**1.00**	0.43	0.47	0.43	0.24	0.48	0.25	0.05
11	Core Real Estate	0.34	0.32	0.34	0.32	0.13	0.05	0.07	0.22	0.21	0.43	**1.00**	0.97	0.32	0.18	0.85	0.15	0.06
12	Non-Core Real Estate	0.45	0.43	0.44	0.41	0.12	0.04	0.07	0.30	0.29	0.47	0.97	**1.00**	0.37	0.22	0.89	0.19	0.07
13	Private Equity	0.62	0.60	0.56	0.53	0.07	0.03	0.08	0.40	0.41	0.43	0.32	0.37	**1.00**	0.32	0.45	0.30	0.06
14	Infrastructure	0.34	0.34	0.31	0.29	0.11	0.05	0.07	0.22	0.22	0.24	0.18	0.22	0.32	**1.00**	0.64	0.15	0.06
15	Closed-End Real Assets	0.52	0.50	0.50	0.46	0.14	0.05	0.09	0.34	0.33	0.48	0.85	0.89	0.45	0.64	**1.00**	0.22	0.08
16	Private Debt	0.38	0.36	0.38	0.40	-0.17	0.07	0.23	0.68	0.56	0.25	0.15	0.19	0.30	0.15	0.22	**1.00**	0.01
17	Inflation	0.07	0.07	0.10	0.07	0.29	-0.02	-0.02	0.09	0.03	0.05	0.06	0.07	0.06	0.06	0.08	0.01	**1.00**

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Asset-Liability Study Results

Michigan State Police Retiree Health Benefits (SPRS) – OPEB

January 2023

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Table of Contents

1 Executive Summary

2 Analysis

- Asset-Liability Profile
- Portfolio Analysis
- Asset-Liability Projection Analysis
- Liquidity Analysis

3 Summary and Conclusions

4 Appendix

1

Executive Summary

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** and how they interact

When?

- Aon suggests conducting asset-liability studies every **3 to 5 years** depending on client specifics, or more frequently should circumstances dictate

How?

- **Identify future trends** in the financial health of the fund based on economic uncertainties that may not be evident from an actuarial valuation

Executive Summary

Summary and Conclusions

Mix of Return-Seeking vs. Risk-Reducing Assets

- Plan is currently underfunded, expected to become fully funded by 2033
- Current portfolio is well-constructed with a high likelihood of meeting/exceeding the actuarial assumed rate of return
- Consider lower risk portfolios given funded status trajectory

Liquidity

- Net outflow is projected to increase over the next few decades
- Consider a slight increase to liquid assets

Funding Interaction

- Funding policy and expected returns provide buffers that mitigate contribution volatility

Investment Strategies Studied

Alternative Policy Provides More Liquidity Given Increasing Net Outflows

Asset Class	Current Policy (87.5% R-S)	Alternative Policy (85% R-S)	Difference	Current Rebalancing Ranges	Alternative Rebalancing Ranges
Equity					
- U.S. Equity	25.0%	25.0%	--	17% - 32%	17% - 32%
- International Equity	15.0%	15.0%	--	12% - 22%	12% - 22%
- Private Equity	16.0%	16.0%	--	13% - 25%	13% - 27%
- Subtotal	56.0%	56.0%	--		
Absolute Return / Liquid Alternatives					
- Subtotal	9.0%	9.0%	--	5% - 11%	5% - 11%
Real Return / Opportunistic					
- Subtotal	12.5%	10.0%	(2.5%)	8% - 18%	8% - 18%
Real Estate & Infrastructure					
- Subtotal	10.0%	10.0%	--	8% - 18%	8% - 18%
Risk-Reducing					
- Short-Term Fixed Income (Cash)	2.0%	2.0%	--	1% - 8%	1% - 8%
- Long-Term Fixed Income (Core Fixed Income)	10.5%	13.0%	+2.5%	8% - 18%	8% - 18%
- Subtotal	12.5%	15.0%	--		
Expected Return[1]	**8.16%**	**8.04%**	**(0.12%)**		
Expected Risk[1]	13.84%	13.50%	(0.34%)		
Sharpe Ratio	0.38	0.38	--		
Probability of Meeting/Exceeding 6.00%	**81%**	**80%**	**(1.0%)**		
1-Year Downside Return (2 Standard Deviations)	**-18.6%**	**-18.1%**	**+0.5%**		
Illiquid Assets	**47.1%**	**44.6%**	**(2.5%)**		

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.

Key Takeaways:

- Modest reduction in forecasted return; more meaningful reduction in forecasted volatility
  - Similar Sharpe Ratio
  - Better one-year downside return
- Over a 30-year timeframe, the alternative policy would be assumed to surpass its return hurdle 80% of the time
- Increase in plan liquidity in response to forecasted cash flow needs as well as adding tactical flexibility
- Compared to peers, Michigan is at the lower end of fixed income allocations

2

Analysis

- Asset-Liability Profile
- Portfolio Analysis
- Asset-Liability Projection Analysis
- Liquidity Analysis

Asset-Liability Profile

Section 2: Analysis

Current State Asset-Liability Profile (as of June 30, 2022)

SPRS OPEB Projects To Have a Hurdle Rate Surplus

Asset-Liability Snapshot				
	As of 9/30/2021		Est. as of 6/30/2022	
Metric ($, Millions)	**Value**	**Fund %**	**Value**	**Fund %**
Market Value of Assets	$372.9	47.8%	$364.6	45.9%
Actuarial Value of Assets	$371.9	47.7%		
Liability Metrics				
Actuarial Liability (AL) – Funding[1]	$780.1		$794.1	

Asset-Liability Growth Metrics			
Metric ($, Millions)	**Value**	**% Liability**	**% Assets**
AL Discount Cost	$49.6	6.25%	13.61%
AL Normal Cost	$10.6	1.33%	2.90%
Plan Expenses	$0.1	0.02%	0.04%
Total Liability Hurdle Rate	**$60.3**	**7.60%**	**16.55%**
Expected Return on Assets[2]	$29.7	3.75%	8.16%
Total Contributions	$49.2	6.20%	13.50%
Total Exp. Asset Growth	**$79.0**	**9.95%**	**21.66%**
Hurdle Rate (Shortfall)/Surplus	**$18.6**	**2.35%**	**5.11%**
Est. Benefit Payments	$42.9	5.40%	11.77%

Key Takeaways:

- Pension plan is estimated to be **45.9%** funded on a market value of assets basis as of June 30, 2022
- Asset hurdle rate of **16.55%**, via cash funding and investment returns, needed to maintain or improve funded status
- The total expected asset growth rate (EROA plus contributions) exceeds the liability hurdle rate by **511 bps**

Target Asset Allocation as of 6/30/2022		
Metric ($, Millions)	**Value**	**Alloc %**
Return-Seeking		
- U.S. Equity	$91.2	25.0%
- Private Equity	$58.3	16.0%
- International Equity	$54.7	15.0%
- Real Return / Opportunistic	$45.6	12.5%
- Real Estate & Infrastructure	$36.5	10.0%
- Absolute Return	$32.8	9.0%
- Total	$319.1	87.5%
Risk-Reducing		
- Cash & Short Term Fixed Income	$7.3	2.0%
- Long Term Fixed Income	$38.3	10.5%
- Total	$45.6	12.5%
Total	$364.6	100.0%

[1] Based on a 6.20% discount rate consistent with the September 30, 2021 actuarial valuation results.

[2] Expected returns are using AIUSA Q3 2022 30-Year Capital Market Assumptions (CMAs) as of June 30, 2022, which are projections about the future returns of asset classes. For asset classes that can be implemented passively, which includes most public assets, alpha and active management fees are not included in the return expectations. For asset classes that can only be implemented actively, such as hedge funds and private assets, we assume alpha and higher active manager fees. Expected returns are geometric (long-term compounded). Expected returns presented are models and do not represent the returns of an actual client account. Your actual returns will be reduced by your advisory fees and other expenses you may incur as a client. AIUSA's advisory fees are described in Part 2A of AIUSA's Form ADV. Not a guarantee of future results. See appendix for capital market assumptions disclosure pages.

Percentages may not sum to 100% due to rounding.

Asset Hurdle Rates

What is the Asset Hurdle Rate?

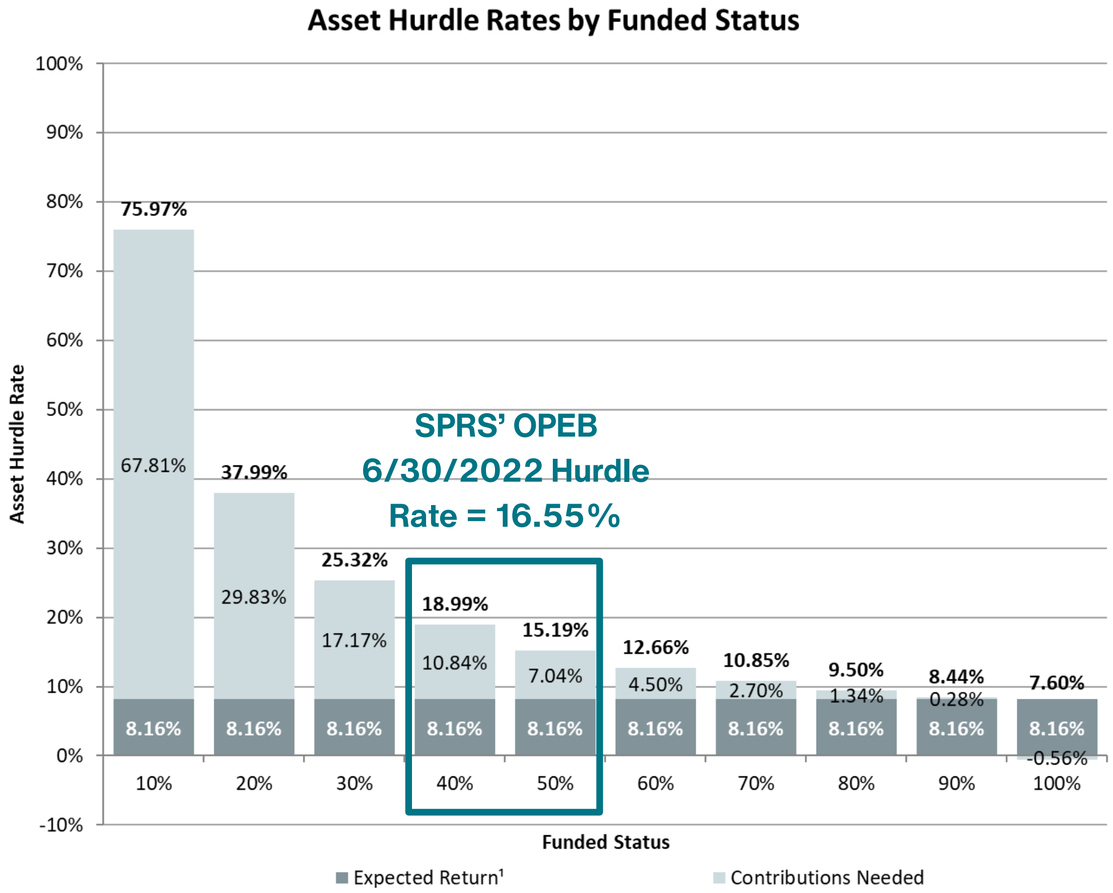
Asset Hurdle Rate is the required rate of asset growth needed to keep pace with the growth of the Plan liabilities

- Assets must grow at this rate or more in order to maintain or reduce a potential funding shortfall
- **Formula = (Normal Cost + Discount Cost + Expenses) / Funded Ratio**

Assets can grow in two ways:

- Investment returns
- Funding contributions

Asset hurdle rates are expected to decline as the funded status increases



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Portfolio Analysis

Section 2: Analysis

Portfolio Analysis

Capital Market Assumption Mapping of Current Target Asset Allocation

The Current Target Asset Allocation is modeled using our capital market assumptions as follows:

Target Asset Allocation as of June 30, 2022		
	Allocation %	**Capital Market Assumption Mapping**
Return-Seeking		
- U.S. Equity	25.0%	90% U.S. Large Cap / 10% U.S. Small Cap
- Private Equity	16.0%	Private Equity
- International Equity	15.0%	75% International Developed / 25% Emerging Markets
- Real Return / Opportunistic	12.5%	50% Private Equity / 50% Multi-Asset Credit
- Real Estate & Infrastructure	10.0%	68% Non-Core Real Estate / 12.75% Core Real Estate / 4.25% U.S. REITs / 15% Infrastructure
- Absolute Return	9.0%	65% Hedge Funds (Direct -- Median Manager) / 35% Private Debt Direct Lending
- Total	87.5%	
Risk-Reducing		
- Cash & Short Term Fixed Income	2.0%	Cash
- Long Term Fixed Income	10.5%	Core Fixed Income
- Total	12.5%	
Total	100.0%	

Portfolio Analysis | Spectrum of Our Model Portfolios

Reflects Our Best Ideas for a Typical Pension Plan

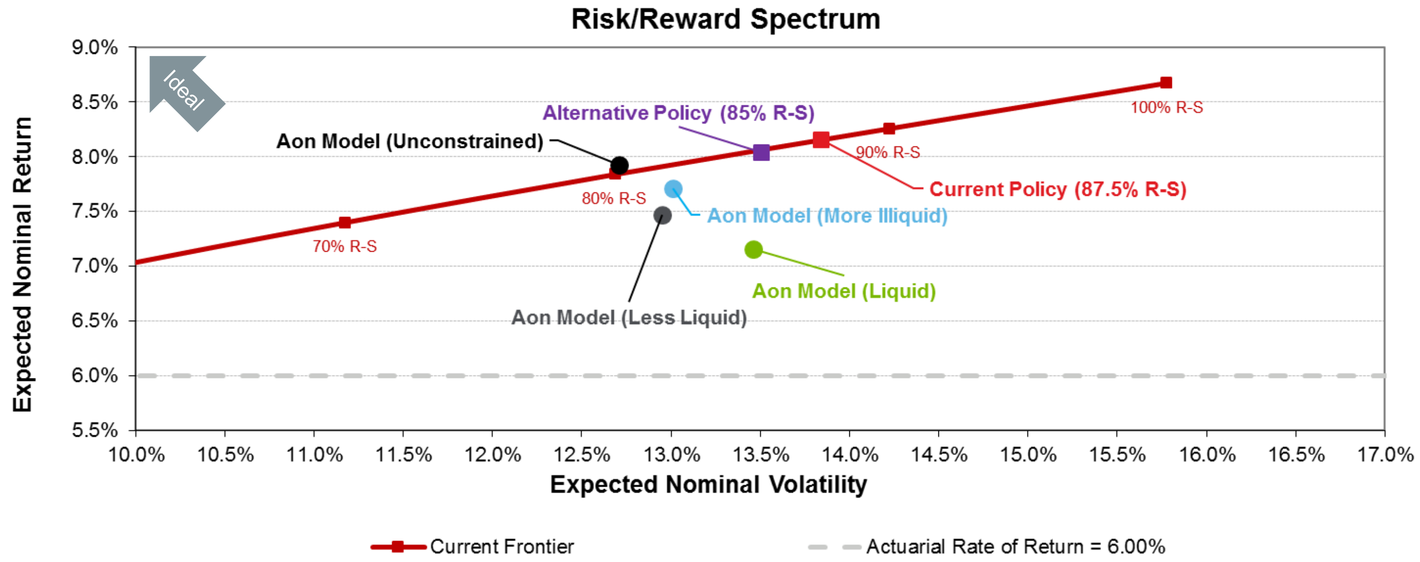
Aon's Model Portfolios reflect Aon's best ideas for a typical total return defined benefit plan across a range of circumstances noted below

- Intended as a ***starting point*** for asset allocation analysis and decision-making and to be customized based on client-specific needs and circumstances

	Liquid	Less Liquid	More Illiquid	Unconstrained
Complexity	Simple			Complex
Costs	Low Cost			Higher Cost
Resources	Light Resources			Deep Resources
Governance	Modest Governance			Strong Governance
Liquidity	More Liquid			Less Liquid

- As a general statement, moving from left-to-right on the above spectrum increases both investment portfolio return potential and risk-adjusted return potential, based on our capital markets modelling
  - It also increases the reliance on "alpha" (manager skill) and reduces the emphasis on market "beta" (market risk premiums); alpha is not guaranteed

Portfolio Analysis
Risk/Reward Spectrum



Notes:

- **Red** Square: "Current Policy" = Michigan's current mix of Risk-Reducing assets (12.5%) and Return-Seeking assets (87.5%)
  - **Red** Line "Current Frontier" = Michigan's Current Policy, scaled to different risk levels (Risk-Reducing assets [FI and cash] and Return-Seeking assets [all other assets] scaled up and down proportionally)
- **Purple** Square: "Alternative Policy" = Michigan's Current Policy with a 2.5% adjustment from Real Return / Opportunistic to Long Term Fixed Income
- Circles (**Green**, **Blue**, **Gray**, **Black**) = "Aon Model Portfolios" – i.e., Aon's starting point for Asset Allocation discussions with clients
  - "Liquid" is designed for clients with a low level of resources / low tolerance for portfolio complexity;
  - "Unconstrained" is for clients at the other end of the resource / complexity spectrum

Key Takeaways:

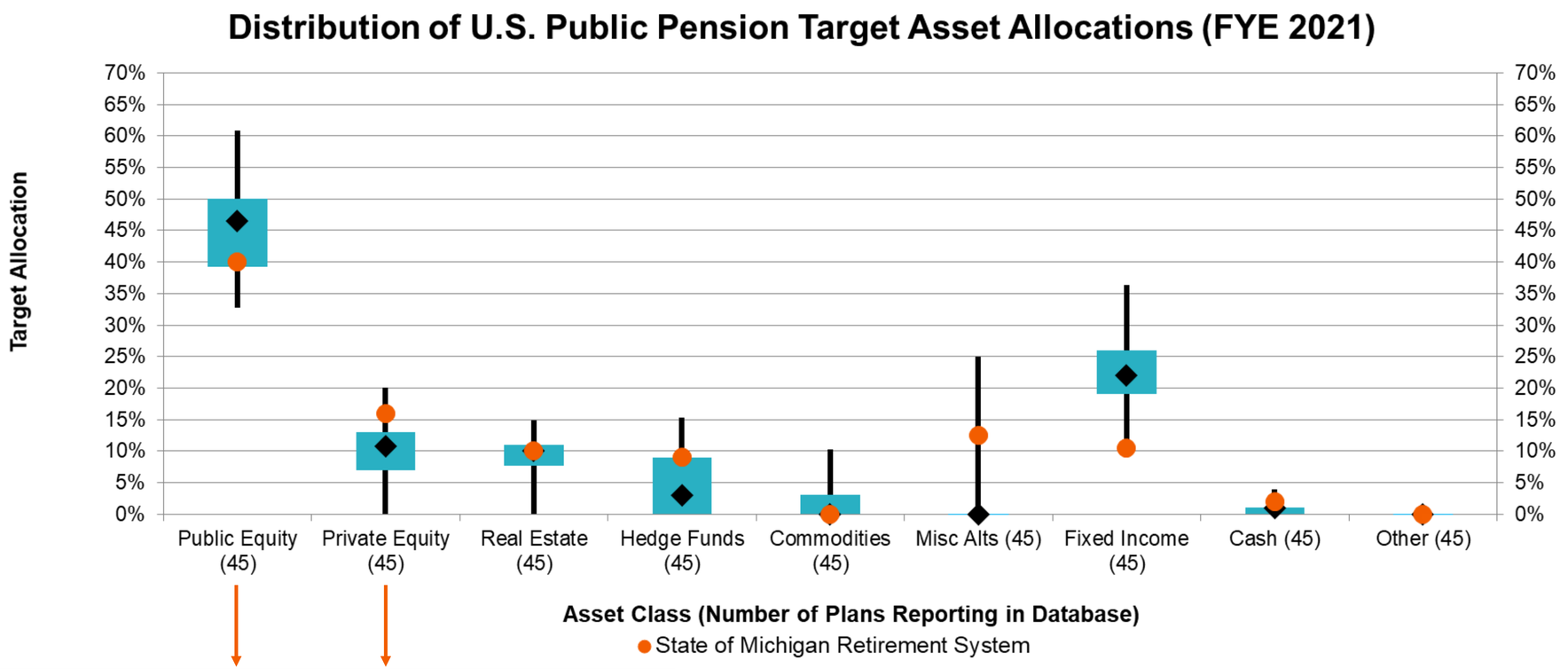
- Current & Alternative Policies have a higher long-term return forecast than any Aon Model Portfolio
- Current Frontier is more efficient than three of the four Aon Model Portfolios
- Current & Alternative Policies model as more volatile (i.e., has a higher standard deviation of forecasted investment returns) than the Aon Model portfolios

	Expected Nominal Return[1]	Expected Nominal Volatility	Sharpe Ratio
Current Policy (87.5% R-S)	8.16%	13.84%	0.38
Alternative Policy (85% R-S)	8.04%	13.50%	0.38
Aon Model (Liquid)	7.16%	13.46%	0.32
Aon Model (Less Liquid)	7.47%	12.95%	0.35
Aon Model (More Illiquid)	7.71%	13.01%	0.37
Aon Model (Unconstrained)	7.92%	12.71%	0.40

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.

Portfolio Analysis

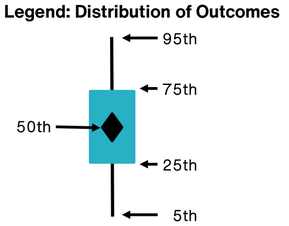
Distribution of U.S. Public Pension Target Asset Allocations (Assets > $25B)[1]



	Public Equity	Private Equity	Total Equity
Michigan	40%	16%	56%
Public Peers	46%	11%	57%
Difference	(6%)	+5%	(1%)

Key Observations:

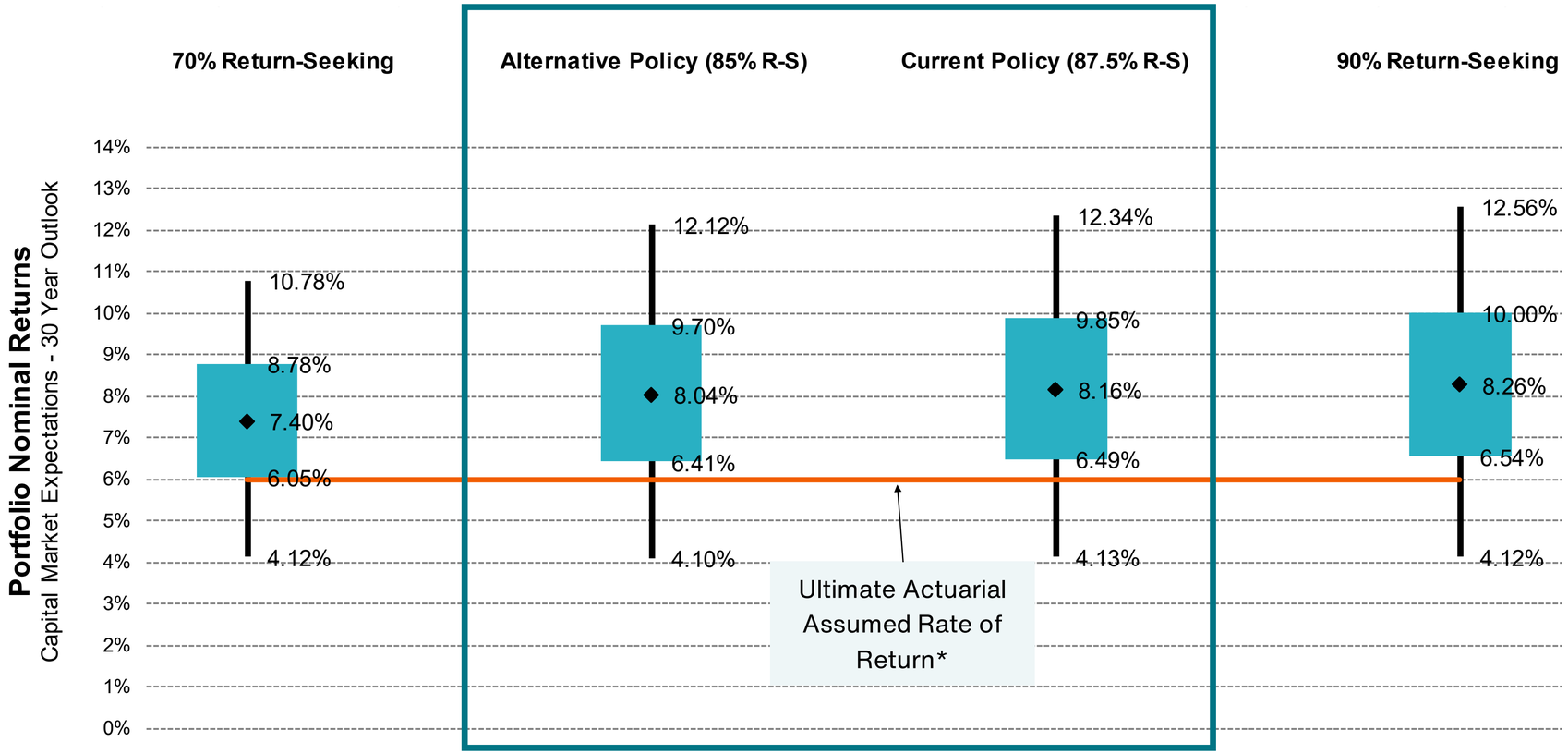
- Michigan's total equity allocation (public + private) is similar to public plans with greater than $25 billion in assets
- Michigan's fixed income allocation is at the 5th percentile relative to peers with $25 billion in assets



Source: Public Plans Data (publicplansdata.org) as of July 2022
[1] Peers defined as public funds published within publicplansdata.org as of July 2022; Number of plans per year are shown in parentheses
* Data point references the Michigan Public Schools Retirement System for comparison purposes

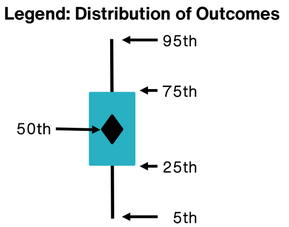
Portfolio Analysis

Range of Nominal Returns[1]



Key Takeaways:

- Median expected returns for policies greater than 50% return-seeking assets are projected to exceed the ultimate actuarial assumed rate of return (6.00%)
- Current Policy has an 81% likelihood of surpassing the 6.00% ultimate actuarial assumed rate of return



[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.

* State Police Retire Health System remains subject to the Dedicated Gains Policy with a current actuarial rate of return of 6.20% and an ultimate rate of 6.00%

Asset-Liability Projection Analysis

Section 2: Analysis

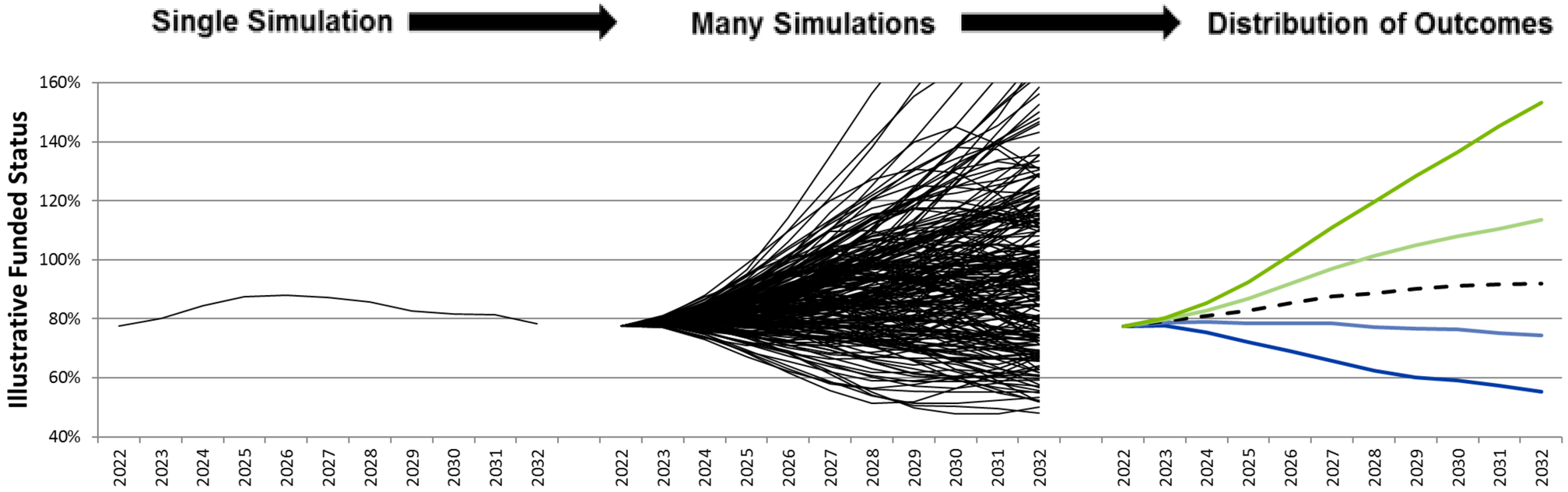
Asset-Liability Simulation Overview

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



Asset-Liability Projection Analysis

Contribution Policy Impacts the Projected Financials

Michigan SPRS' OPEB contribution policy is unique and has these three (3) key characteristics:

Floor Provision

- The floor provisions serve to advance funding in good scenarios, building a buffer to be used to offset future increases
  - In good times, the contributions will not decrease until full funding
  - In bad times, the contributions will increase and re-set the floor for future years

Closed Amortization

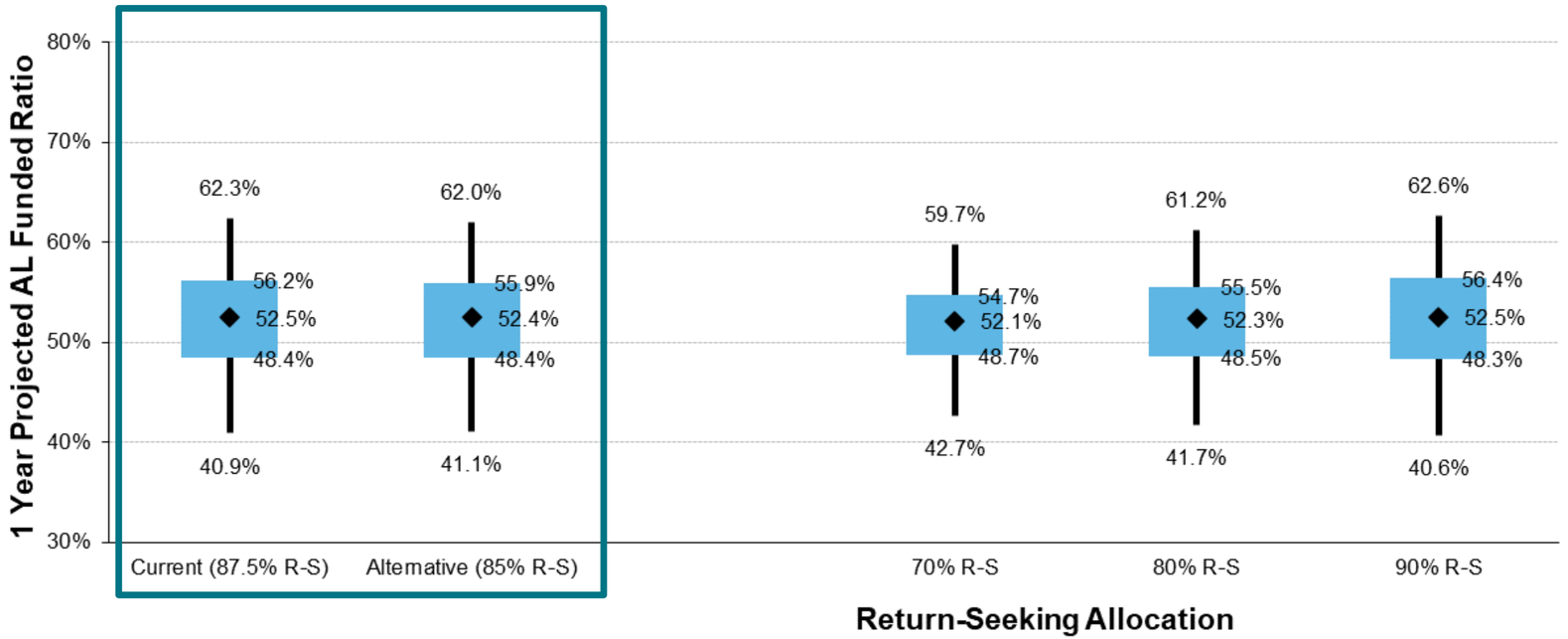
- The closed amortization policy forces full funding by a specific date
  - By itself, volatility will increase in the future as that period moves to immediate recognition
  - Along the way, volatility is subdued based on a buffer that has accumulated under each specific path

Banking Excess Returns

- Excess returns greater than the actuarial rate will build a buffer which can be used to offset future contribution increases

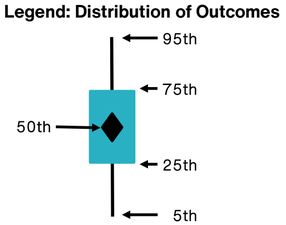
Asset-Liability Projection Analysis

Short-Term (1 Year) | Market Value of Assets / Actuarial Liability Funded Ratio



Key Takeaways:

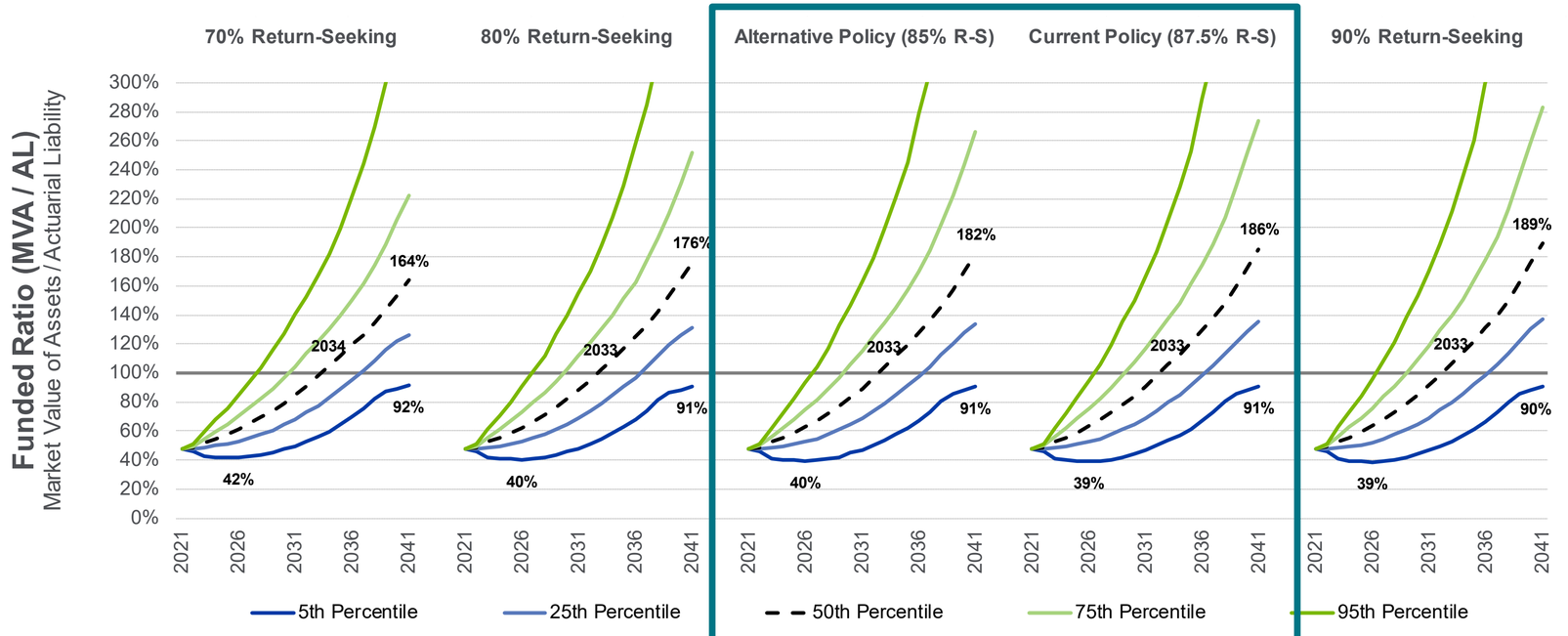
- Higher risk portfolios are projected to have both more upside and downside potential over a short time horizon (1 year in this exhibit)
- Similarly, lower risk portfolios will have a narrower range of potential outcomes



* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Asset-Liability Projection Analysis

Long-Term | Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	70% Return-Seeking			80% Return-Seeking			Alternative Policy (85% R-S)			Current Policy (87.5% R-S)			90% Return-Seeking		
Year	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041
5th Percentile	42%	50%	92%	40%	48%	91%	40%	47%	91%	39%	47%	91%	39%	47%	90%
25th Percentile	53%	68%	126%	53%	69%	131%	52%	69%	134%	52%	69%	135%	52%	69%	137%
50th Percentile	61%	85%	164%	62%	88%	176%	63%	89%	182%	63%	90%	186%	64%	91%	189%
75th Percentile	70%	105%	>200%	73%	112%	>200%	74%	115%	>200%	75%	117%	>200%	76%	119%	>200%
95th Percentile	85%	140%	>200%	90%	155%	>200%	93%	163%	>200%	95%	167%	>200%	96%	170%	>200%

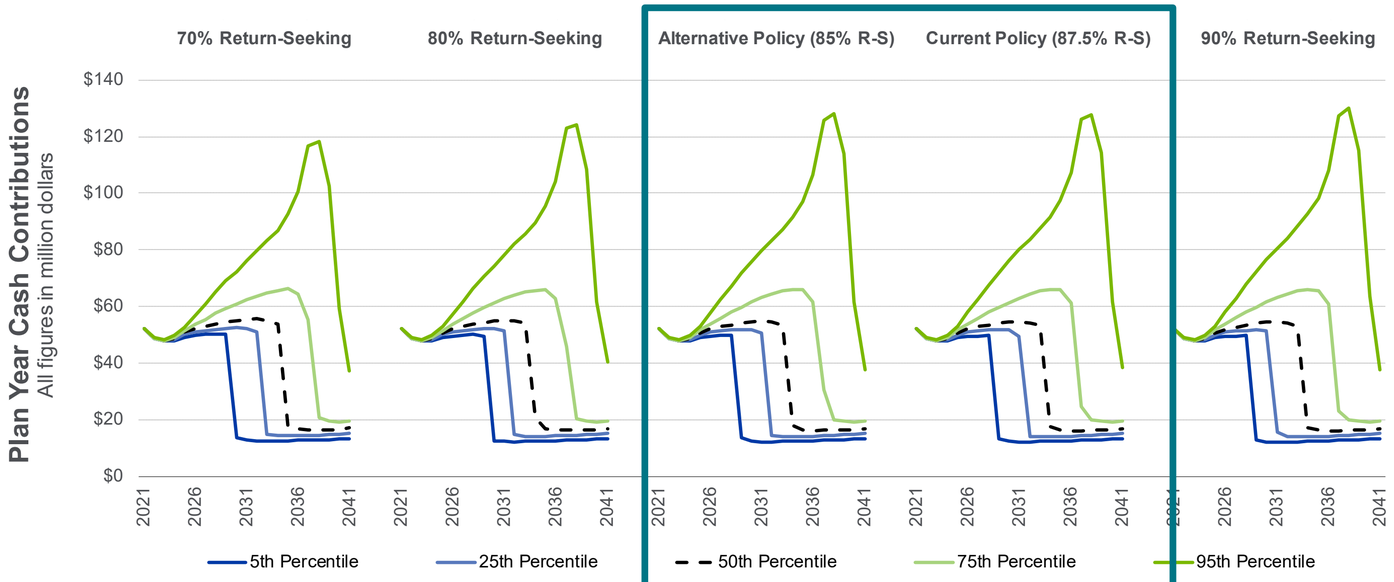
* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Key Takeaways:

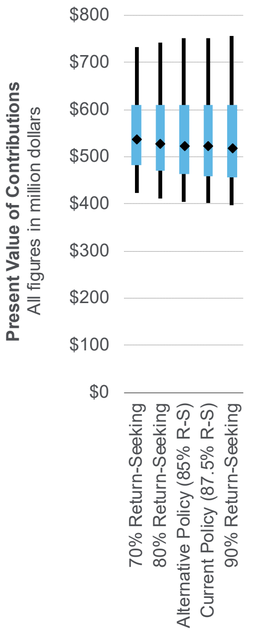
- Under the Current Policy (87.5% R-S), the funded ratio is expected to move towards full funding by FYE 2033 in the central expectation (50th percentile outcome)
- Contribution policy is projected to close the funding shortfall across investment strategies modeled
- Higher return-seeking allocations will increase the central trendline of funded ratio faster, albeit with more volatility

Asset-Liability Projection Analysis

Total Contribution Amounts (Employer + Employee)

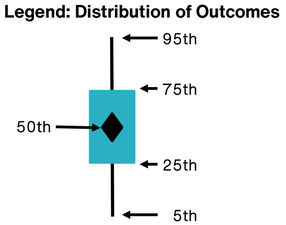


Strategy	70% Return-Seeking			80% Return-Seeking			Alternative Policy (85% R-S)			Current Policy (87.5% R-S)			90% Return-Seeking		
Year	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041
5th Percentile	$50	$13	$13	$49	$12	$13	$49	$12	$13	$49	$12	$13	$49	$12	$13
25th Percentile	$51	$52	$15	$51	$51	$15	$51	$51	$15	$51	$50	$15	$51	$16	$15
50th Percentile	$52	$55	$17	$52	$55	$17	$52	$55	$17	$52	$55	$17	$52	$54	$17
75th Percentile	$54	$62	$20	$54	$63	$20	$54	$63	$20	$54	$63	$20	$54	$63	$20
95th Percentile	$57	$76	$37	$57	$78	$40	$58	$80	$38	$58	$80	$39	$58	$80	$38



Key Takeaway:

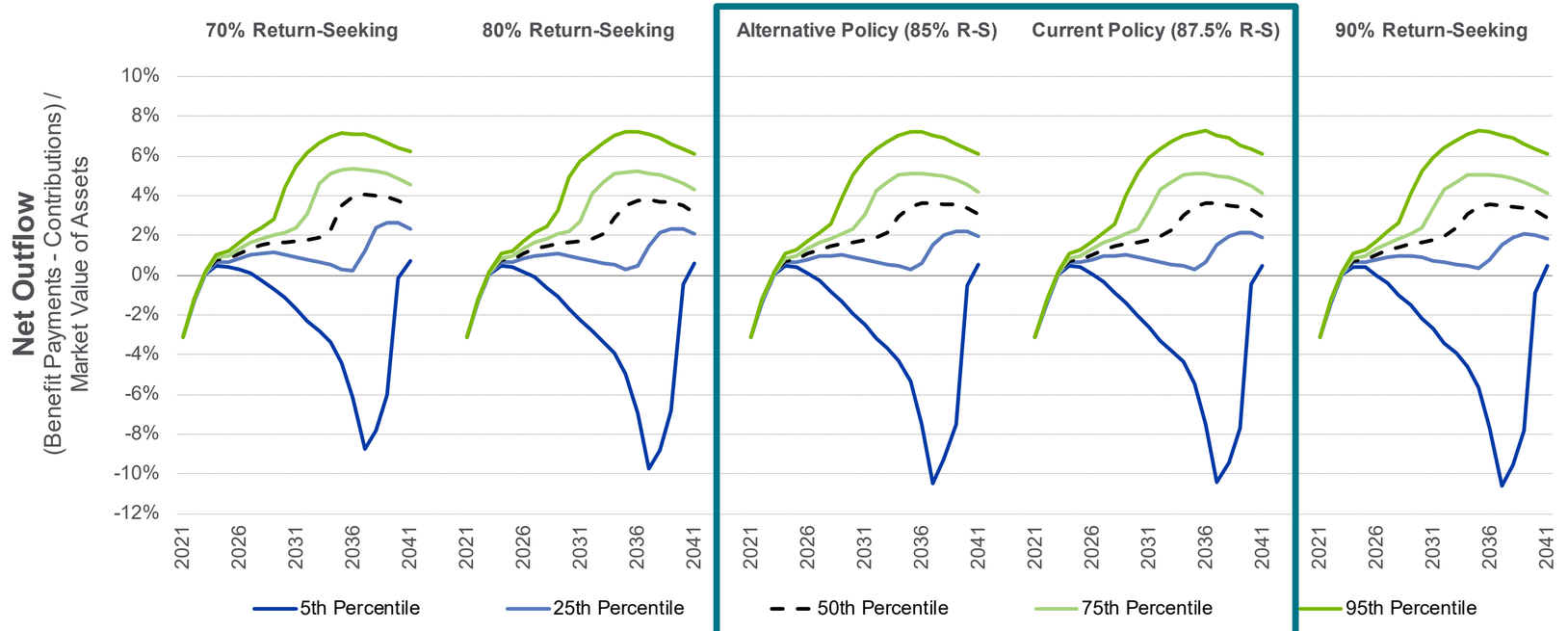
- The higher the allocation to return-seeking assets, the lower the present value of future contributions will be on average but the greater the variability in contributions



* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Asset-Liability Projection Analysis

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



Strategy	70% Return-Seeking			80% Return-Seeking			Alternative Policy (85% R-S)			Current Policy (87.5% R-S)			90% Return-Seeking		
Year	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041
5th Percentile	0.3%	-1.7%	0.7%	0.2%	-2.2%	0.6%	0.1%	-2.5%	0.5%	0.1%	-2.6%	0.5%	0.0%	-2.7%	0.5%
25th Percentile	0.9%	0.9%	2.4%	0.8%	0.8%	2.1%	0.8%	0.8%	1.9%	0.8%	0.8%	1.9%	0.8%	0.7%	1.8%
50th Percentile	1.1%	1.7%	3.4%	1.1%	1.7%	3.2%	1.1%	1.8%	3.0%	1.0%	1.8%	3.0%	1.0%	1.8%	2.9%
75th Percentile	1.3%	2.4%	4.5%	1.3%	2.7%	4.3%	1.3%	3.0%	4.2%	1.3%	3.2%	4.1%	1.3%	3.4%	4.1%
95th Percentile	1.7%	5.5%	6.2%	1.7%	5.7%	6.1%	1.7%	5.9%	6.1%	1.7%	5.9%	6.1%	1.7%	5.9%	6.1%

Key Takeaways:

- The Plan is assumed to have net outflows increase over the projection period
- Net outflows are expected to increase to the 1-4% range over the projection period
- Net outflows of 10%+ can put stress on fund liquidity over time; however, it is not likely over the projection period

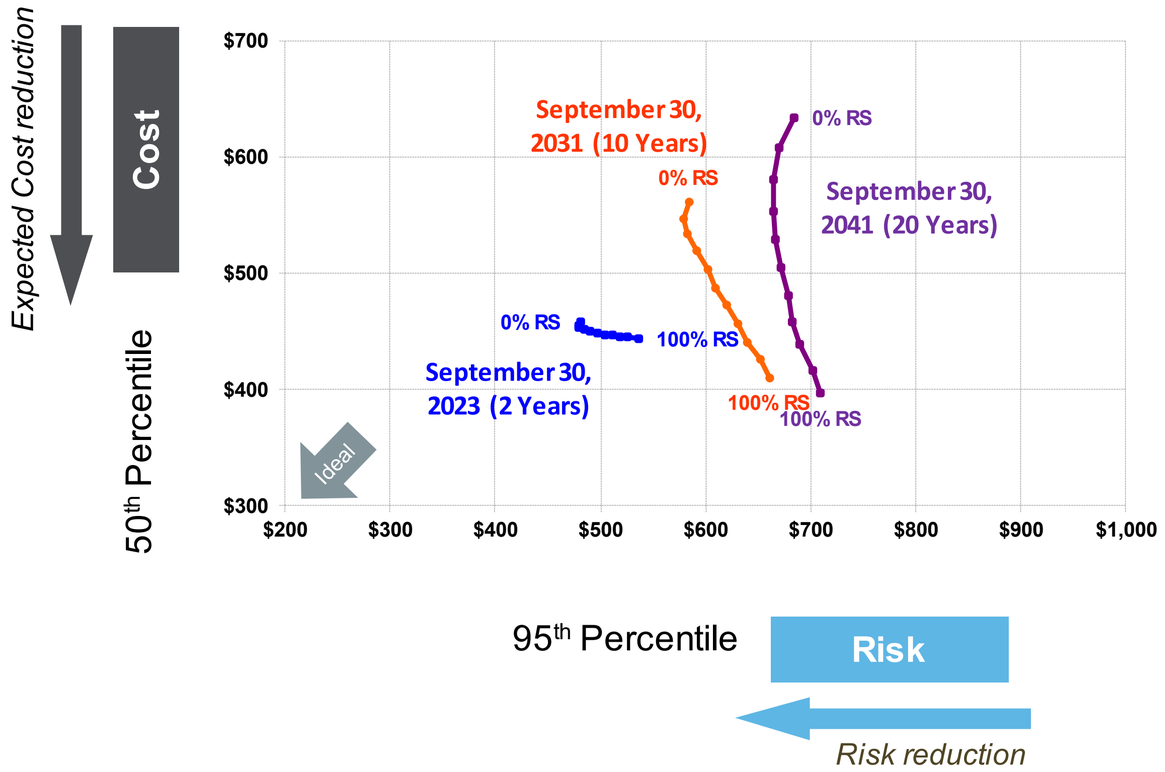
* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Asset-Liability Projection Analysis

Economic Cost Analysis over a 2, 10, and 20-Year Horizon

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 6.25%, $millions



* Projections assume starting discount rate of 6.25% for pension liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%
Note: Excludes 50% of surplus in excess of 120% of Actuarial liability, and includes twice the shortfall below 40% of Actuarial liability, on a market value basis

Key Takeaways:

- Short time horizons (2 years) show largely horizontal economic cost curves – i.e., added risk does not result in a significant expected reward/economic cost reduction
- Longer time horizons (20 years) show largely vertical economic cost curves – i.e., added risk does result in a significant expected reward/economic cost reduction

Asset-Liability Projection Analysis

Actuarial Assumed Rate of Return

Strategy	70% Return-Seeking			80% Return-Seeking			Alternative Policy (85% R-S)			Current Policy (87.5% R-S)			90% Return-Seeking		
Year	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041	2026	2031	2041
5th Percentile	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
25th Percentile	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
50th Percentile	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
75th Percentile	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
95th Percentile	6.3%	6.0%	6.0%	6.3%	6.0%	6.0%	6.3%	6.0%	6.0%	6.3%	6.0%	6.0%	6.3%	6.0%	6.0%

* Projections assume starting discount rate of 6.25% for OPEB liabilities for all investment policies studied and follow the Dedicated Gains Policy as appropriate to a discount rate floor of 6.00%

Key Takeaway:

- Across all policies modeled, the actuarial assumed rate of return is projected to move based on the Dedicated Gains Policy from the current 6.25% to the ultimate 6.00%

Liquidity Analysis

Section 2: Analysis

Liquidity Analysis
Background

Michigan State Police Retiree Health Benefits (SPRS OPEB) liquidity analysis is performed under its Current Policy (87.5% R-S) and Alternative Policy (85.0% R-S) portfolios

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 Dark Skies scenario (e.g. many hedge funds, open-end real assets)

Illiquid: Potential lock-up of 5–10 years, depending on economic environment (e.g. closed-end real assets)

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

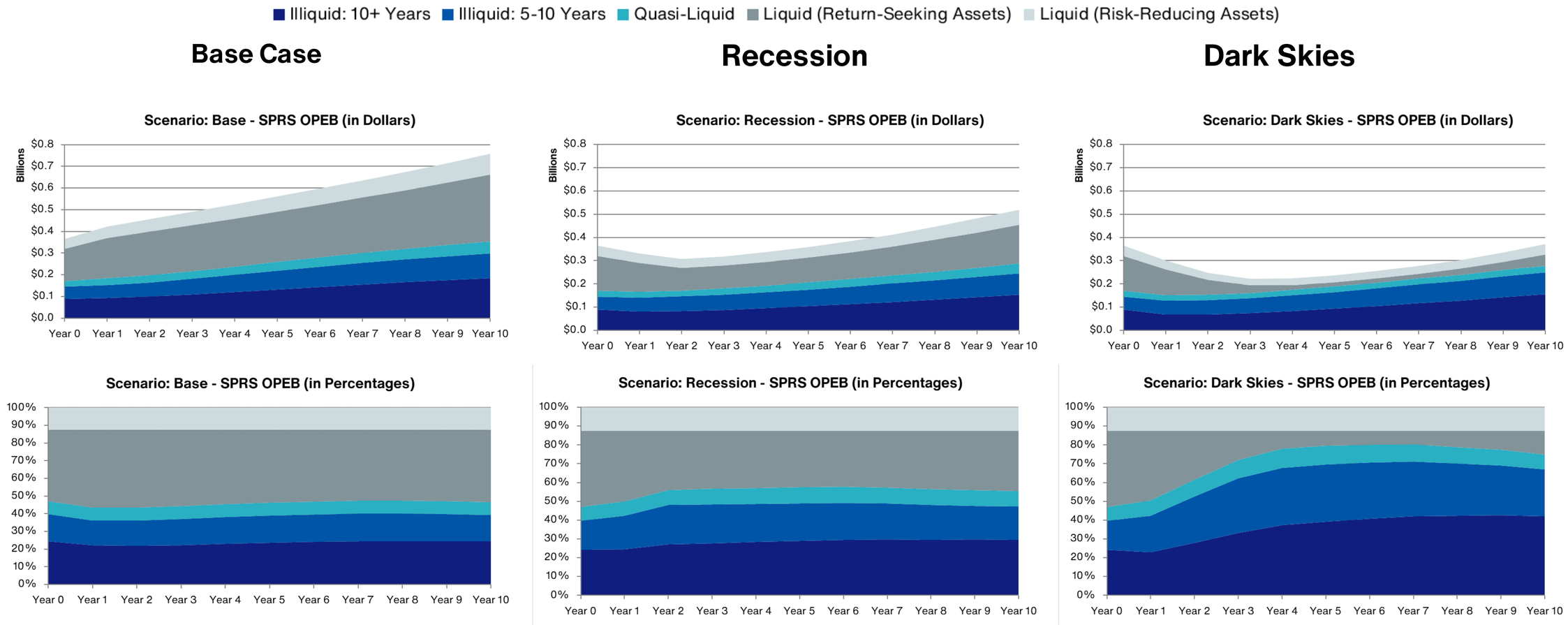
Liquidity Analysis

Asset Allocation and Liquidity Category (Current Policy)

	Asset Class	Target Asset Allocation				
		Liquid	*Quasi-Liquid*	*Illiquid 5-10 Years*	*Illiquid 10+ Years*	*Total*
Return-Seeking	U.S. Equity Equity	25.00%				25.00%
	Private Equity				16.00%	16.00%
	International Equity	15.00%				15.00%
	Real Return / Opportunistic			12.50%		12.50%
	Real Estate & Infrastructure	0.425%	1.275%		8.30%	10.00%
	Absolute Return		6.00%	3.00%		9.00%
	Subtotal	40.425%	7.275%	15.50%	24.30%	87.50%
Risk-Reducing/ Safety	Cash & Short Term Fixed Income	2.00%				2.00%
	Long Term Fixed Income	10.50%				10.50%
	Subtotal	12.50%	0.00%	0.00%	0.00%	12.50%
	Total	52.925%	7.275%	15.50%	24.30%	100.00%

47.1% illiquid assets

Liquidity Analysis
Current Policy (87.5% Return-Seeking)



Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

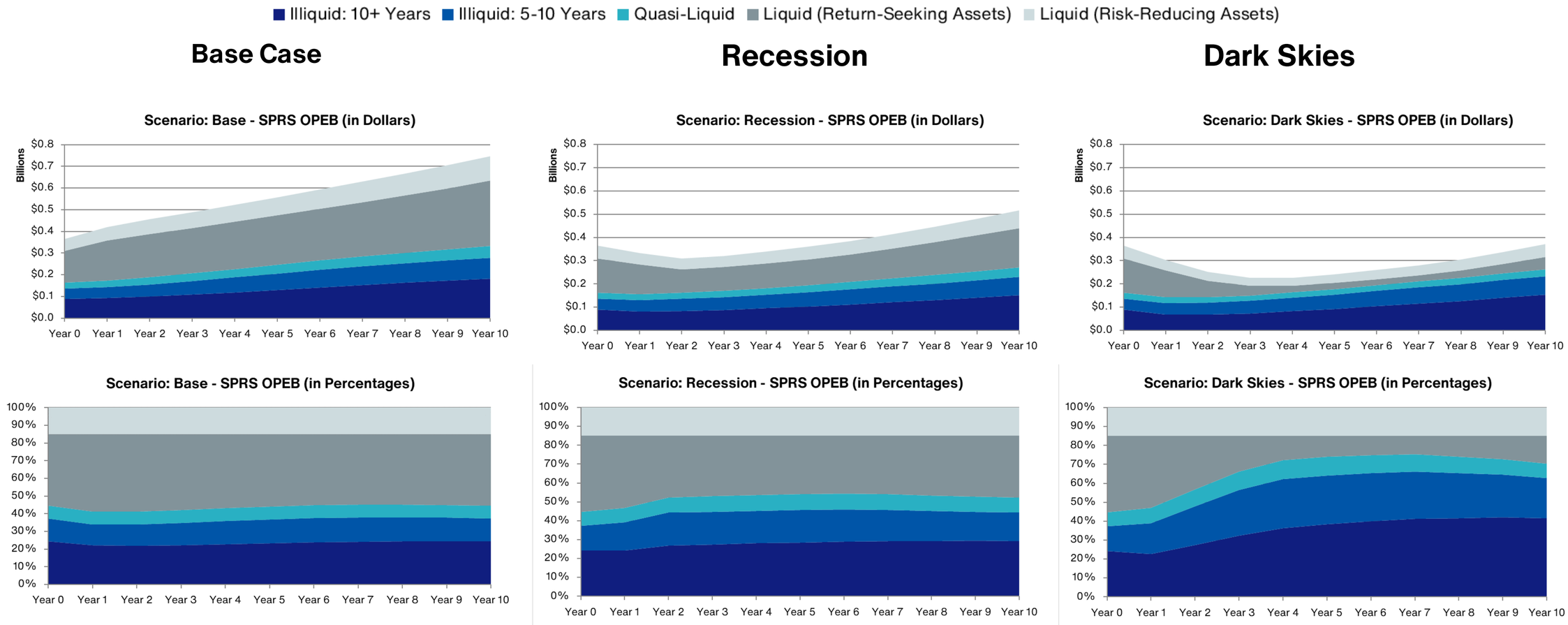
Asset Allocation and Liquidity Category (Alternative Policy)

	Asset Class	Target Asset Allocation				
		Liquid	*Quasi-Liquid*	*Illiquid 5-10 Years*	*Illiquid 10+ Years*	*Total*
Return-Seeking	U.S. Equity Equity	25.00%				25.00%
	Private Equity				16.00%	16.00%
	International Equity	15.00%				15.00%
	Real Return / Opportunistic			10.00%		10.00%
	Real Estate & Infrastructure	0.425%	1.275%		8.30%	10.00%
	Absolute Return		6.00%	3.00%		9.00%
	Subtotal	40.425%	7.275%	13.00%	24.30%	85.00%
Risk-Reducing/ Safety	Cash & Short Term Fixed Income	2.00%				2.00%
	Long Term Fixed Income	13.00%				13.00%
	Subtotal	15.00%	0.00%	0.00%	0.00%	15.00%
	Total	55.425%	7.275%	13.00%	24.30%	100.00%

44.6% illiquid assets

Liquidity Analysis

Alternative Policy (85% Return-Seeking)



Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis
Conclusions

Both the Current Portfolio (87.5% R-S) and Alternative Portfolio (85% R-S) have sufficient liquidity in most economic scenarios, but a very pessimistic scenario such as a Dark Skies could be problematic:

- Asset levels fall significantly and SPRS OPEB would have difficulty rebalancing illiquid assets
  - Actuarial factors – such as the contribution policy, the contribution lag, and asset smoothing parameters – act as additional headwinds in the Dark Skies scenario, delaying contributions into the future
- SPRS OPEB may need to scale back its alternative asset allocation at a time when the opportunity may be greatest

The Recession scenario has results that are directionally similar to the Dark Skies scenario, but much less extreme

This analysis is highly sensitive to the assumed contributions

- If SPRS OPEB receives less contributions than assumed, especially in a Dark Skies environment, then the liquidity issue could be worse than projected here
- If SPRS OPEB receives more contributions when the funded status is low, it would reduce the liquidity stresses

3

Summary & Conclusions

Summary of Results

R-S%	30Y Expected Return[1]	30Y Nominal Volatility	Sharpe Ratio	1Y Return (2 STD Down)	20-year Economic Cost (in $ Millions)		20-year Present Value of Contributions (in $ Millions)		20-year Ending Funded Ratio (MVA / AL)	
					Expected[2]	Downside[3]	Expected[2]	Downside[3]	Expected[2]	Downside[4]
Current Policy (87.5% R-S)	8.16%	13.84%	0.38	-18.6%	$422.6	$698.5	$523.3	$752.7	186%	91%
Alternative Policy (85% R-S)	8.04%	13.50%	0.38	-18.1%	$428.7	$697.6	$524.7	$751.2	182%	91%
Current Frontier of Results										
70.0%	7.40%	11.17%	0.40	-14.4%	$458.8	$682.5	$537.8	$731.9	164%	92%
72.5%	7.51%	11.55%	0.40	-15.0%	$453.2	$685.1	$535.4	$733.9	167%	91%
75.0%	7.62%	11.93%	0.40	-15.6%	$447.7	$687.1	$533.3	$737.2	170%	91%
77.5%	7.73%	12.31%	0.39	-16.2%	$442.9	$688.7	$531.1	$740.0	173%	91%
80.0%	7.84%	12.69%	0.39	-16.8%	$438.2	$690.3	$528.7	$743.2	176%	91%
82.5%	7.95%	13.07%	0.39	-17.4%	$433.2	$693.1	$526.1	$745.9	179%	91%
85.0%	8.05%	13.45%	0.38	-18.0%	$428.6	$695.7	$524.9	$749.3	183%	91%
87.5%	8.16%	13.84%	0.38	-18.6%	$422.6	$698.5	$523.3	$752.7	186%	91%
90.0%	8.26%	14.22%	0.38	-19.3%	$417.1	$701.7	$520.1	$755.4	189%	90%

[1] Expected returns based on Aon Investments Q3 2022 30-year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. 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 Appendix for the Capital Market Assumptions.
[2] Expected = 50th percentile outcome or central expectation across all 5,000 simulations
[3] Downside = 95th percentile outcome across all 5,000 simulations
[4] Downside = 5th percentile outcome across all 5,000 simulations

Key Takeaways:

- All else equal, we believe SPRS OPEB would benefit from reducing its investment risk posture, at least at the margin
- The alternative policy is projected to result in:
  - Lower expected returns, nominal volatility, downside (95th percentile) contribution amounts, and more favorable one year downside return.
  - Similar Sharpe Ratio (i.e., same efficiency) and expected attainment of full funding
  - Slightly higher expected (50th percentile) contribution amounts

Summary and Conclusions

Mix of Return-Seeking vs. Risk-Reducing Assets

- Plan is currently underfunded, expected to become fully funded by 2033
- Current portfolio is well-constructed with a high likelihood of meeting/exceeding the actuarial assumed rate of return
- Consider lower risk portfolios given funded status trajectory

Liquidity

- Net outflow is projected to increase over the next few decades
- Consider a slight increase to liquid assets

Funding Interaction

- Funding policy and expected returns provide buffers that mitigate contribution volatility

4

Appendix

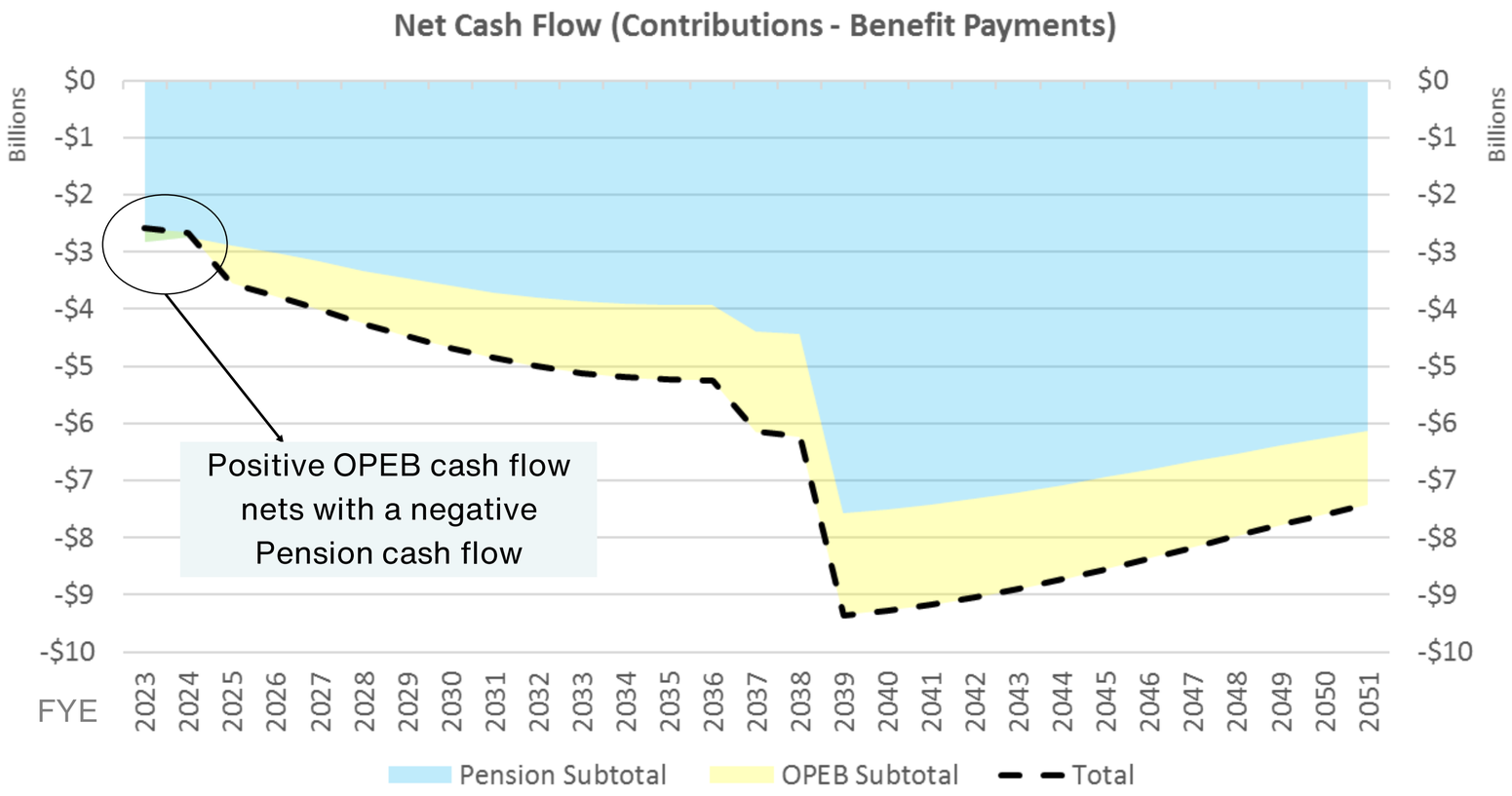
- Additional Asset-Liability Analysis
- Methods & Assumptions
- 2021 Horizon Survey Results
- Liquidity Analysis Detail
- How Do Public Pensions Impact Credit Ratings?
- Asset-Liability Management Background
- Glossary of Terms
- About This Material

Additional Asset-Liability Analysis

Section 4: Appendix

Aggregate Net Cash Flow Analysis

Michigan Is Projected to Have a Total Net Cash Outflow, Driven By the Pension Plans

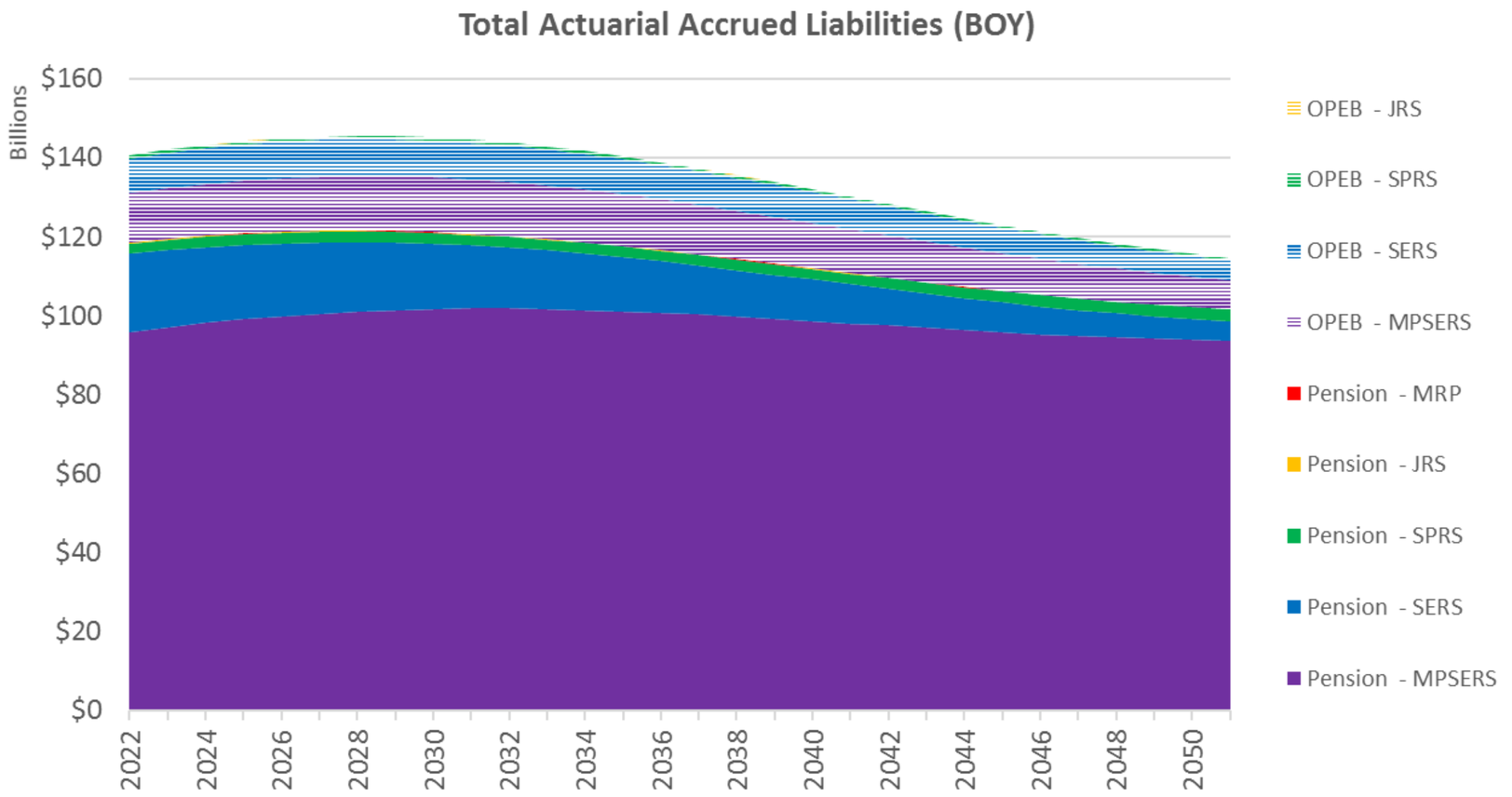


Key Observations:

- Baseline actuarial data provided by GRS
- Aggregate pension plans are shown in blue; aggregate OPEB plans in yellow
- Michigan is projected to have an aggregate baseline of negative cash flow with more going out in benefit payments than coming in via contributions
- Closed amortization policy drives the sharp change mid-projection period
- Both the aggregate pension and aggregate OPEB plans are assumed to increasingly become more cash flow negative with each passing decade

Aggregate Liability Analysis

Based on GRS' Baseline Projections | Total Liability Peaks in Fiscal Year Ending 2028



Key Observations:

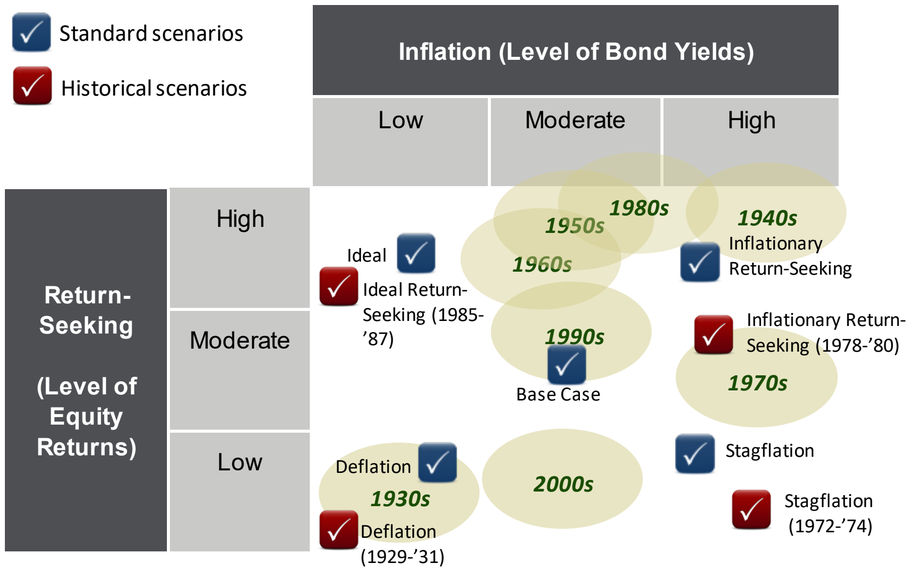
- Individual systems are color-coded; pension plans are shown in solid colors with OPEB plans in stripes
- Based on GRS' projections, the aggregate liability reaches its peak in Fiscal Year Ending 2028

Asset-Liability Projection Analysis

Scenario Analysis

- Five economic scenarios were modeled in this report
- The economic scenarios vary by the average level of growth and inflation over the forecast period
- The chart below provides historical context for the five scenarios

- Simulations reflecting these characteristics were drawn from the total of all simulations
- Level of Inflation was based on the average yield on 10yr Treasuries
- Level of Growth was based on the average return on Global Equity
- Simulations were then grouped into scenarios based on the deciles of inflation and growth: 1st through 3rd deciles were considered "Low", 4th through 7th considered "Moderate", and 8th through 10th considered "High"



Standard scenarios	Inflation (Level of Bond Yields)		
	Low Avg yield = 2.2%	Moderate Avg yield = 3.4%	High Avg yield = 5.0%
Return-Seeking (Level of Equity Returns)			
High Avg return = 16.0%	✓ 6% weight	11% weight	✓ 13% weight
Moderate Avg return = 9.2%	12% weight	✓ 17% weight	11% weight
Low Avg return = 2.4%	✓ 12% weight	12% weight	✓ 6% weight

Asset-Liability Projection Analysis

“What if?" Scenario Analysis | 10-Year Funded Ratio Projections

Economic Environment

Low Growth, High Inflation

Inflation expectations take-off as monetary stimulus feeds through to much higher commodity prices

Low Growth, Low Inflation

The global economy slips back into recession

Moderate Growth, Inflation

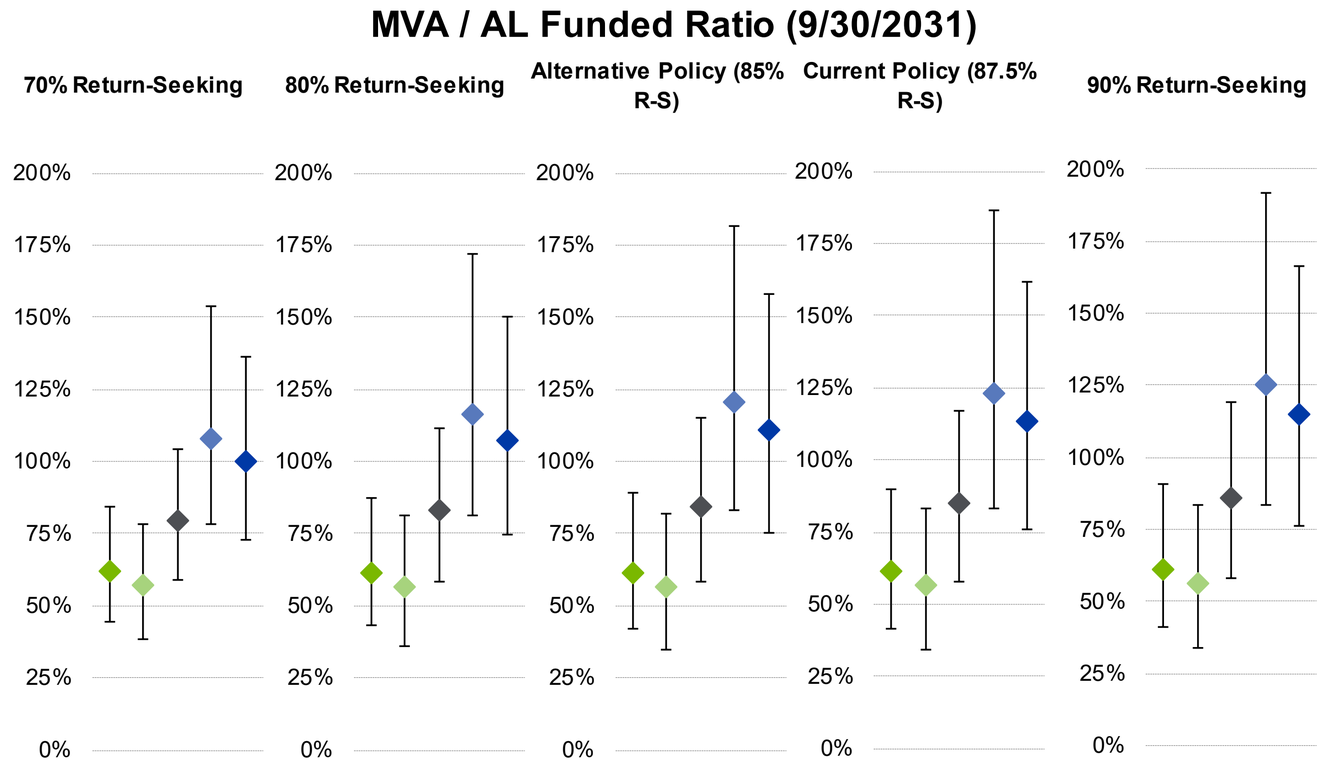
World events unfold in a fashion consistent with our Global Capital Market Assumptions

High Growth, High Inflation

Economy grows more than expected mainly due to inflationary forces

High Growth, Low Inflation

Pronounced cyclical upswing with world Return-Seeking above and even substantially above long-term trend while inflation expectations remain contained



Key Takeaways:

- The Plan performs best in high growth / high inflation scenarios
- Growth scenarios are expected to be the driving force behind funded ratio projections over the next ten years

Contribution Policy Impact on Asset-Liability Study

Overview

- Michigan's asset-liability study results are heavily influenced by its contribution policy, specifically how the following pieces interact:
  - Floor provision
  - Investment strategy expecting a return greater than the actuarial assumptions
  - Closed amortization

- In their individual silo, each provision is also used to some degree by other public pension plans; however, in our experience, their combination is unique to Michigan

Contribution Policy Impact on Asset-Liability Study

Floor Provision

- The following plans have a floor provision on their contribution policy, related to either the normal cost or amortization component of the calculations:
  - MPSERS, SPRS

- The floor provisions serve to advance funding in good scenarios, building a buffer to be used to offset future increases
  - In good times, the contributions will not decrease until full funding
  - In bad times, the contributions will increase and re-set the floor for future years

- A floor provision is utilized in other public pension plans:
  - Nebraska Public Employees Retirement System; San Diego City Employees' Retirement System

Contribution Policy Impact on Asset-Liability Study

Banking Excess Returns

- Based on results from Aon's 6/30/2022 capital market assumptions, the Michigan portfolio has a 30-year expected return assumption of 8.16%

- Over a 30-year timeframe, Michigan would be assumed to surpass its actuarial assumed rate of return (6.00%) in ~81% of scenarios

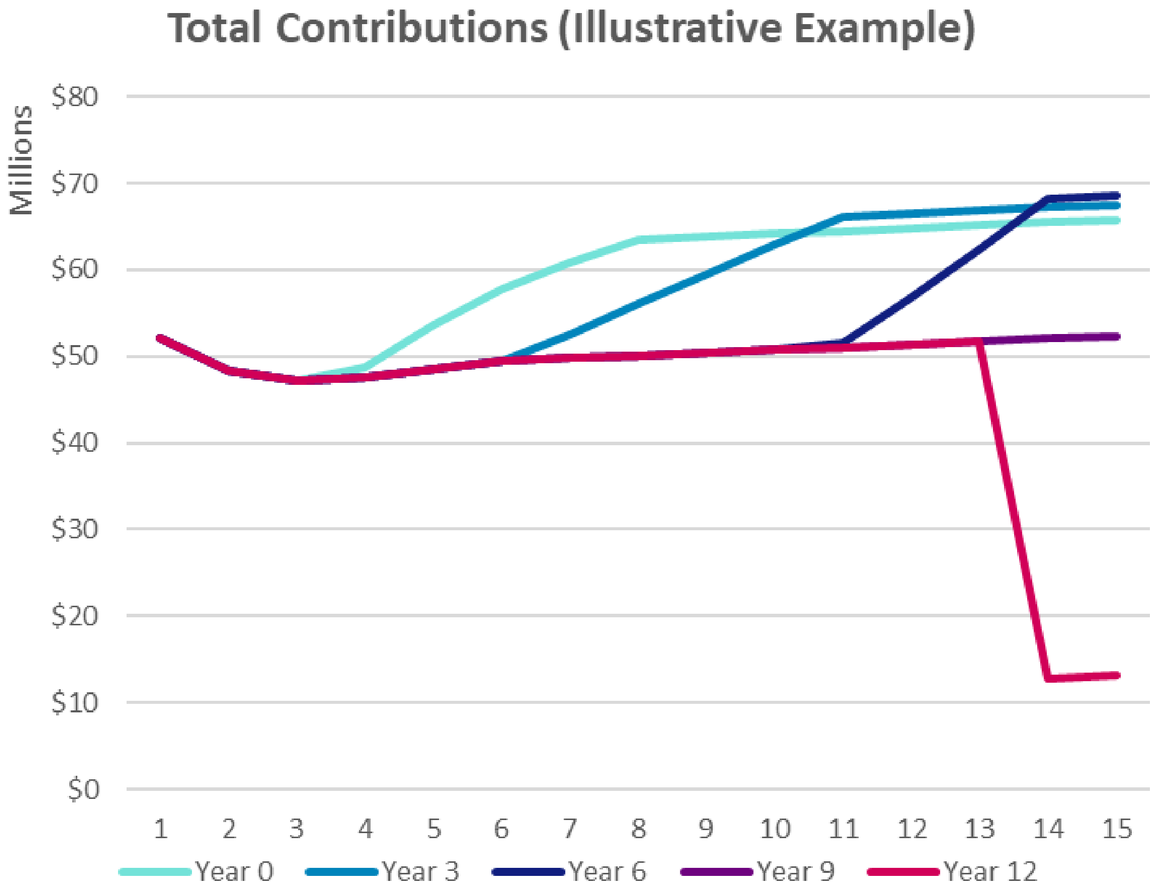
- Similar to the floor provision, excess returns over the actuarial rate will build a buffer to be used to offset future increases

Percentile	Current Policy (87.5% R-S)
5th	4.13%
25th	6.49%
50th	**8.16%**
75th	9.85%
95th	12.34%

Contribution Policy Impact on Asset-Liability Study

Closed Amortization

- The closed amortization policy forces full funding by a specific date; by itself, volatility will increase in the future as that period moves to immediate recognition
- Along the way, volatility is subdued based on the buffer (from the contribution floor and excess asset returns) that has accumulated under each specific path
- The example to the right assumes a 15 year geometric return of 6.00% (the actuarial assumption) with -20% negative shock applied at various points in time (resulting in returns of 8.15% in the other 14 years):
  - The earlier the shock occurs, the more contributions will increase (see shocks in Years 0, 3, and 6)
  - The later the shock occurs, the more likely the Plan has a large enough buffer that contributions will not correspondingly increase (see shock in Years 9 and 12)



Contribution Policy Impact on Asset-Liability Study

Key Findings

- The combination of the floor provision and asset returns expected to be greater than the actuarial assumption is expected to...
  - Keep contributions steady until full funding, advancing contributions rather than realizing any near-term savings
  - Build up a buffer or reserve which can be tapped into in adverse markets

- The closed amortization policy will add volatility to the plan contributions as the time to immediate recognition comes closer
  - That volatility could be dampened depending on the path taken and how much of a buffer has accumulated leading up to adverse market conditions

- **Advancing contributions and creating buffers to insulate negative events are some reasons why a riskier portfolio in our asset-liability modeling may not appear noticeably riskier in the lead-up to full funding**

Methods & Assumptions

Section 4: Appendix

Actuarial Assumptions and Methods

Data

- Actuarial projections provided by the plan actuary (GRS Consulting) as of September 30, 2021 on an open group basis

Actuarial assumptions:

- Valuation Rate of Interest = 6.25% as of September 30, 2021
- Inflation = 2.25%
- Payroll Growth = 2.75%
- Actuarial Value of Assets: determined by recognizing differences between actual and expected investment income over a closed five-year period with a 30% corridor
- All other assumptions as documented in the Actuarial Valuation Report as of September 30, 2021, unless noted otherwise

Contribution Policy

- Normal Cost plus a level percent amortization of the unfunded liability
- For purposes of amortizing the UAAL, a 1.25% payroll growth assumption is used for the September 30, 2021 valuation which decreases by 0.50% each subsequent year until an ultimate payroll growth assumption for amortization purposes of 0.00% is reached beginning with the September 30, 2024 valuation
- Amortization of Unfunded Actuarial Liability uses a closed, 15-year amortization period that will decrease to immediate recognition at expiry

Actuarial Assumptions and Methods

Projection Assumptions

- Actual asset experience through June 30, 2022 was factored in using monthly asset returns from October 2021 through June 2022 as provided by the State of Michigan

Dedicated Gains Policy

- Discount rates were assumed to decrease annually should investment returns exceed expected returns in an amount such that a reduction in the investment return assumption would result in no expected increase in the employer contribution from where it would have been had investment returns equal their assumed
  - Dedicated Gains Policy calculations for all systems other than MPSERS include amounts sufficient to cover the increase in the employer normal cost for the first year only
- Excess investment returns were calculated based on a market value basis
- Excess investment returns were assumed to first be used to reduce the discount rate
- Any excess investment return not used to reduce the discount rate would apply as a gain for actuarial value of assets purposes
- Decreases in discount rates were assumed to stop once the rate reached 6.00%

Our Capital Market Assumptions

As of June 30, 2022 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.8%	7.3%	17.5%
2	Small Cap U.S. Equity	5.3%	7.8%	23.5%
3	International Equity (Developed)	5.1%	7.6%	21.0%
4	Emerging Markets Equity	5.7%	8.2%	24.5%
	Fixed Income			
5	Cash (Gov't)	0.5%	2.9%	2.0%
6	Core Fixed Income	1.3%	3.7%	4.5%
7	Core Plus Fixed Income	1.7%	4.1%	5.0%
8	Multi-Asset Credit[2]	4.4%	6.9%	9.0%
	Alternatives			
9	Direct Hedge Funds[2,3]	3.5%	6.0%	9.5%
10	US REITs	3.9%	6.4%	19.0%
11	Core Real Estate	2.6%	5.1%	15.5%
12	Non-Core Real Estate	4.2%	6.7%	25.5%
13	Private Equity	7.6%	10.2%	25.5%
14	Infrastructure	5.2%	7.7%	15.0%
15	Closed-End Real Assets	5.5%	8.0%	16.0%
16	Private Debt	4.6%	7.1%	17.5%
	Inflation			
17	Inflation	0.0%	2.4%	2.0%

[1] Expected returns are using Aon Investments Q3 2022 30-Year 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.

[2] Alpha incorporated in Expected Nominal Return

[3] Represents diversified portfolio of Direct hedge fund investments.

Our Capital Market Assumptions

As of June 30, 2022

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Large Cap U.S. Equity	**1.00**	0.93	0.81	0.73	0.07	0.02	0.08	0.61	0.66	0.65	0.34	0.45	0.62	0.34	0.52	0.38	0.07
2	Small Cap U.S. Equity	0.93	**1.00**	0.75	0.68	0.06	0.02	0.07	0.57	0.62	0.61	0.32	0.43	0.60	0.34	0.50	0.36	0.07
3	International Equity (Developed)	0.81	0.75	**1.00**	0.76	0.03	0.01	0.07	0.62	0.56	0.54	0.34	0.44	0.56	0.31	0.50	0.38	0.10
4	Emerging Markets Equity	0.73	0.68	0.76	**1.00**	0.06	0.03	0.08	0.64	0.46	0.50	0.32	0.41	0.53	0.29	0.46	0.40	0.07
5	Cash (Gov't)	0.07	0.06	0.03	0.06	**1.00**	0.41	0.36	0.04	-0.03	0.07	0.13	0.12	0.07	0.11	0.14	-0.17	0.29
6	Core Fixed Income	0.02	0.02	0.01	0.03	0.41	**1.00**	0.98	0.25	0.04	0.02	0.05	0.04	0.03	0.05	0.05	0.07	-0.02
7	Core Plus Fixed Income	0.08	0.07	0.07	0.08	0.36	0.98	**1.00**	0.39	0.18	0.06	0.07	0.07	0.08	0.07	0.09	0.23	-0.02
8	Multi-Asset Credit	0.61	0.57	0.62	0.64	0.04	0.25	0.39	**1.00**	0.68	0.40	0.22	0.30	0.40	0.22	0.34	0.68	0.09
9	Direct Hedge Funds	0.66	0.62	0.56	0.46	-0.03	0.04	0.18	0.68	**1.00**	0.42	0.21	0.29	0.41	0.22	0.33	0.56	0.03
10	US REITs	0.65	0.61	0.54	0.50	0.07	0.02	0.06	0.40	0.42	**1.00**	0.43	0.47	0.43	0.24	0.48	0.25	0.05
11	Core Real Estate	0.34	0.32	0.34	0.32	0.13	0.05	0.07	0.22	0.21	0.43	**1.00**	0.97	0.32	0.18	0.85	0.15	0.06
12	Non-Core Real Estate	0.45	0.43	0.44	0.41	0.12	0.04	0.07	0.30	0.29	0.47	0.97	**1.00**	0.37	0.22	0.89	0.19	0.07
13	Private Equity	0.62	0.60	0.56	0.53	0.07	0.03	0.08	0.40	0.41	0.43	0.32	0.37	**1.00**	0.32	0.45	0.30	0.06
14	Infrastructure	0.34	0.34	0.31	0.29	0.11	0.05	0.07	0.22	0.22	0.24	0.18	0.22	0.32	**1.00**	0.64	0.15	0.06
15	Closed-End Real Assets	0.52	0.50	0.50	0.46	0.14	0.05	0.09	0.34	0.33	0.48	0.85	0.89	0.45	0.64	**1.00**	0.22	0.08
16	Private Debt	0.38	0.36	0.38	0.40	-0.17	0.07	0.23	0.68	0.56	0.25	0.15	0.19	0.30	0.15	0.22	**1.00**	0.01
17	Inflation	0.07	0.07	0.10	0.07	0.29	-0.02	-0.02	0.09	0.03	0.05	0.06	0.07	0.06	0.06	0.08	0.01	**1.00**

Aon's Capital Market Assumptions

Background

Long-term (10- and 30-year forecasts) forward-looking assumptions (asset class geometric return, volatility, and correlations)

Building Block approach, primarily based on consensus expectations and market-based inputs

Best estimates of annualized returns (50/50 better or worse)

Market returns: no active management value added (except for certain assets classes, such as hedge funds)

Net of investment fees

Updated quarterly

We show Aon's long-term (i.e., 30-year) capital market assumptions throughout this material

Aon's Capital Market Assumption Framework

Building Block Approach

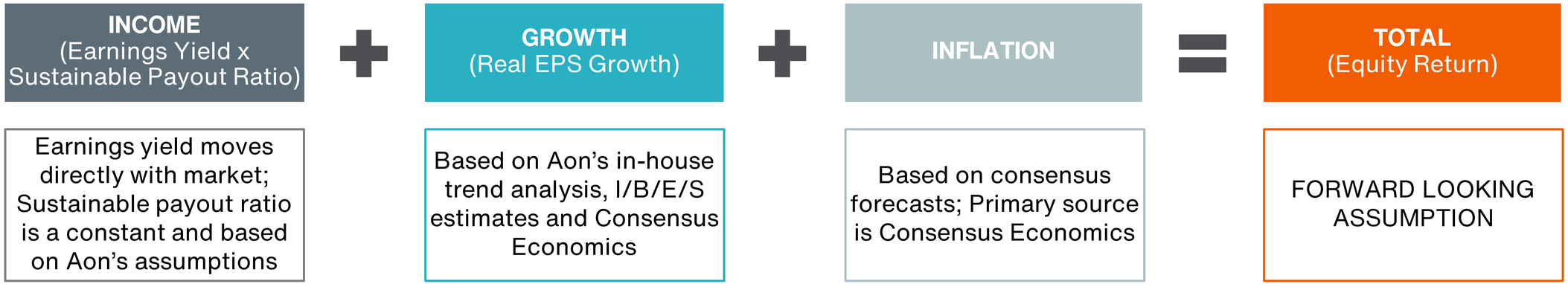
Expected return estimates for equity and fixed income are developed using a building block approach

Expected returns based on observable information in the equity and fixed income markets and consensus estimates for major economic and capital market inputs, such as earnings and inflation

Where necessary, judgment-based modifications are made to these inputs

Return assumptions for other asset classes are based on historical results, current market characteristics, and professional judgment from our specialist research teams

Example: Public Equities



Explanation of Capital Market Assumptions

As of June 30, 2022 (30 Years)

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 2022. 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 (2.4%)

Based on Consensus Economics long-term estimates and our near-term economic outlook, we expect U.S. consumer price inflation to be approximately 2.4% during the next 30 years.

Real Returns for Asset Classes

Fixed Income

- **Cash (0.5%)** – Over the long run, we expect the real yield on cash and money market instruments to produce a real return of 0.5% in a moderate to low-inflationary environment.
- **TIPS (1.0%)** – We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about 0.0%.
- **Core Fixed Income (i.e., Market Duration)** (1.3%) – We expect intermediate duration Treasuries to produce a real return of about 0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.8%, resulting in a long-term real return of 1.3%.
- **Core Plus Bonds (1.7%)** – Modeled as 20% 5 duration gov't with real return of 0.5% and 80% 5 duration corporate bonds with real return of 2.0%.
- **Long Duration Bonds – Government and Credit (1.9%)** – We expect Treasuries with a duration comparable to the Long Government Credit Index to produce a real return of 1.1%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.8%, resulting in an expected real return of 1.9%.

Explanation of Capital Market Assumptions

As of June 30, 2022 (30 Years)

- **Long Duration Bonds – Credit (2.4%)** – We expect Treasuries with a duration comparable to the Long Credit Index to produce a real return of 1.1%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 1.3%, resulting in an expected real return of 2.4%.
- **Long Duration Bonds – Government (1.1%)** – We expect Treasuries with a duration of ~12 years to produce a real return of 1.1% during the next 30 years.
- **High Yield Bonds (3.3%)** – We expect intermediate duration Treasuries to produce a real return of about 0.5%. 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 3.3%.
- **Bank Loans (3.7%)** – We expect LIBOR to produce a real return of about 1.1%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults) to be 2.6%, resulting in an expected real return of 3.7%.
- **Non-US Developed Bonds: 50% Hedged (0.9%)** – We forecast real returns for non-US developed market bonds to be 0.9% 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) (3.3%)** – We forecast real returns for emerging market sovereign bonds denominated in US dollars to be 3.3% over a 30-year period.
- **Emerging Market Bonds (Corporate; USD) (2.7%)** – We forecast real returns for emerging market corporate bonds denominated in US dollars to be 2.7% over a 30-year period.
- **Emerging Market Bonds (Sovereign; Local) (3.9%)** – We forecast real returns for emerging market sovereign bonds denominated in local currency to be 3.9% over a 30-year period.
- **Multi Asset Credit (MAC) (4.4%)** – We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 3.6% plus 0.8% from alpha (net of fees) over a 30-year period.

Explanation of Capital Market Assumptions

As of June 30, 2022 (30 Years)

- **Private Debt-Direct Lending (4.6%) –** The base building block is bank loans 3.7% + spread 0.9% (net of management fees and performance incentives). There is 100% leverage included in the assumption with the nominal cost of financing at LIBOR + 2.5%.

Equities

- **Large Cap U.S. Equity (4.8%)** – 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 (5.3%)** – 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 5.3%. 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) (5.3%)** – 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 5.3% for global equity.
- **International (Non-U.S.) Equity, Developed Markets (5.1%)** – 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 (5.7%)** - 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 (3.8%) –** We expect real returns from 50% equity + 50% cash beta of 3.0% plus 0.8% insurance risk premium over the next 30 years.

Explanation of Capital Market Assumptions
As of June 30, 2022 (30 Years)

Alternative Asset Classes

- **Hedge Fund-of-Funds Universe (2.1%)** – 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 1.1% in return at similar volatility based on alpha, lower fees and better risk management.
- **Hedge Fund-of-Funds Buy List (3.2%)** – 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 (3.5%)** – 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 (4.8%)** – 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 (2.6%)** -- Our real return assumption for core real estate is based a gross income of about 2.6%, management fees of roughly 1%, 25% leverage 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 (4.2%)** -- 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% over core real estate. We assume a 50/50 mix of value-add and opportunistic investments.

Explanation of Capital Market Assumptions

As of June 30, 2022 (30 Years)

- **U.S. REITs (3.9%)** – Our real return assumption for U.S. REITs is based on income of about 3.9% 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 (3.5%)** – 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., 2.4%). Collateral is assumed to be LIBOR cash (1.1%). Also, we believe the roll effect will be near zero, resulting in a real return of about 3.5% for commodities.
- **Private Equity (7.6%)** – Our private equity assumption reflects a diversified fund of funds with exposure to buyouts, venture capital, distressed debt, and mezzanine debt.
- **Infrastructure (5.2%)** – 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 5.2% for infrastructure.
- **Equity Risk Insurance Premium Strategies-Low Beta (2.9%) –** We assume real returns from cash of 0.5% + 2.4% from alpha.
- **Alternative Risk Premia (ARP) (5.0%) –** Real return target LIBOR 1.1% plus 3.9% alpha (net of fees)
- **eLDI (2.8%) –** Combination of various long credit strategies (1/6 real estate debt, 1/3 securitized debt, 1/6 CMOs, 1/3 private placements)
- **Closed-End Real Assets (5.5%) –** Modeled as 50% Non-Core Real Estate and 50% Infrastructure

Explanation of Capital Market Assumptions

As of June 30, 2022 (30 Years)

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.

2021 Horizon Survey Results

Section 4: Appendix

Benchmarking Our Assumptions vs. Peers

2021 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

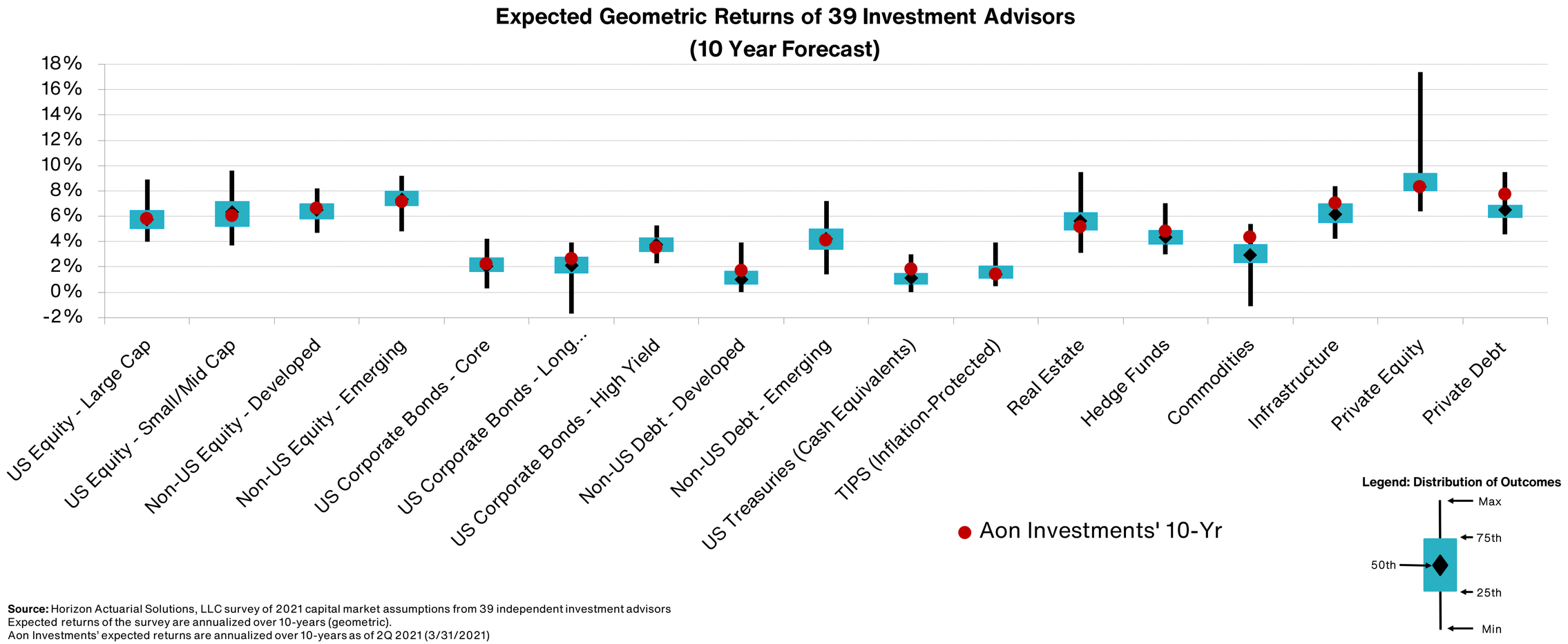
How does Aon compare to the 2021 survey results?

Aon Investments' 2021 10-year forecast assumptions (as of March 31, 2021)

- ***Equities:*** approximately middle of the pack for U.S. and Non-U.S. equities
- ***Fixed Income:*** approximately middle of the pack relative to the survey's median level; higher for U.S. Treasuries
- ***Alternatives:*** approximately middle of the pack relative to the survey's median level; higher for Commodities and Private Debt

Aon Investments' Capital Market Assumptions vs. Horizon Survey

10-Year Forecast



Source: Horizon Actuarial Solutions, LLC survey of 2021 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 2021 (3/31/2021)

2021 Horizon Survey Results

Aon Investments vs. Peers (2021 Horizon Survey) | 10-Year Forecast

	Horizon Survey		Aon Investments		Difference	
	10 Year Horizon		10 Year Forecasts		Aon Investments – Horizon Survey	
Asset Class	**Expected Return**	**Expected Risk**	**Expected Return**	**Expected Risk**	**Expected Return**	**Expected Risk**
US Equity - Large Cap	5.7%	16.4%	5.8%	17.0%	0.1%	0.6%
US Equity - Small/Mid Cap	6.3%	20.2%	6.0%	23.0%	-0.3%	2.8%
Non-US Equity - Developed	6.5%	18.3%	6.6%	20.0%	0.1%	1.7%
Non-US Equity - Emerging	7.3%	24.3%	7.1%	27.0%	-0.2%	2.7%
US Fixed Income - Core	2.0%	5.5%	2.2%	4.0%	0.2%	-1.5%
US Fixed Income - Long Duration Corp	2.1%	10.4%	2.6%	9.0%	0.5%	-1.4%
US Fixed Income - High Yield	3.7%	9.9%	3.5%	12.0%	-0.2%	2.1%
Non-US Fixed Income - Developed	1.0%	7.2%	1.7%	5.5%	0.7%	-1.7%
Non-US Fixed Income - Emerging	4.2%	11.3%	4.1%	13.0%	-0.1%	1.7%
Treasuries (Cash Equivalents)	1.1%	1.3%	1.8%	1.5%	0.7%	0.2%
TIPS (Inflation-Protected)	1.4%	5.6%	1.4%	3.5%	0.0%	-2.1%
Real Estate	5.6%	17.6%	5.1%	15.0%	-0.5%	-2.6%
Hedge Funds	4.3%	8.1%	4.8%	9.0%	0.5%	0.9%
Commodities	2.9%	17.3%	4.3%	17.0%	1.4%	-0.3%
Infrastructure	6.1%	17.0%	7.0%	14.5%	0.9%	-2.5%
Private Equity	8.3%	22.3%	8.3%	25.0%	0.0%	2.8%
Private Debt	6.5%	11.4%	7.7%	16.5%	1.2%	5.1%
Inflation	2.0%	2.1%	2.1%	1.0%	0.1%	-1.1%

Notes (Horizon Survey):

Source: Horizon Actuarial survey of 2021 capital market assumptions from 39 independent investment advisors

Expected returns are median annualized (geometric).

Notes (Aon Investments' Forecasts):

Aon Investments' Forecasts are for Q2 2021

- 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 Fund forecasts represents Aon Investments' forecasts for Direct Hedge Funds (Universe)

2021 Horizon Survey Results

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.

Liquidity Analysis Detail

Section 4: Appendix

Liquidity Analysis
Assumptions

Assumptions

- Starting assets based on the reported June 30, 2022 market value of assets ($365 million)
- The plan's contribution policy is actuarially-based, leveraging the 2022 asset-liability study for projection analysis
- Assumes the portfolio starts at the target asset allocation levels for illiquid assets, maintaining close to the Current Policy portfolio targets over the next 10 years

Liquidity Analysis
Economic Scenarios

Base Case Scenario

- Markets perform consistent with Aon's 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

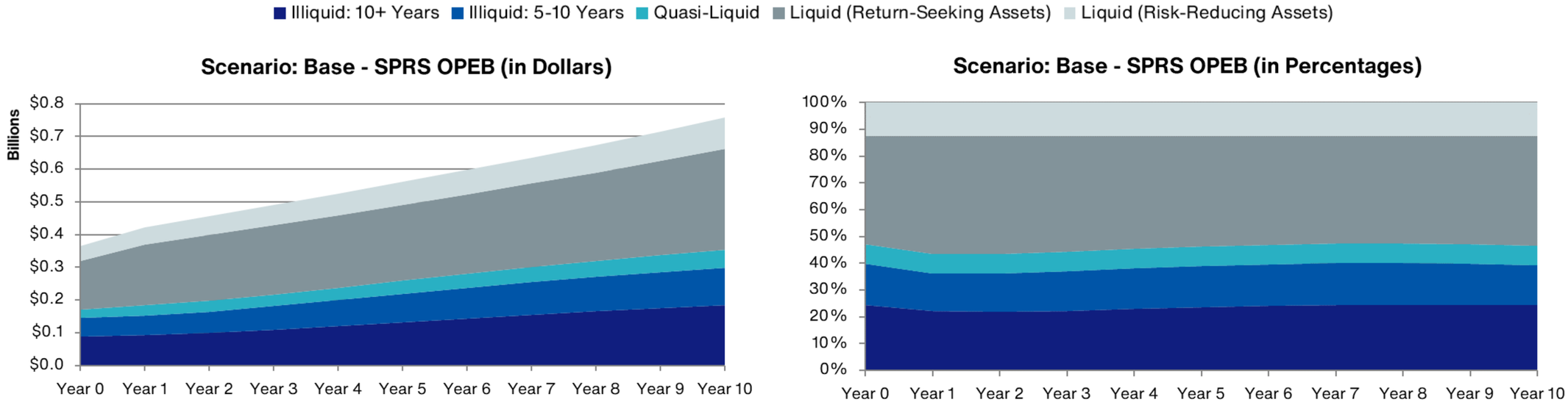
Dark Skies Scenario

- 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

Base Case Economic Scenario – Current Portfolio (87.5% R-S)

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



Key Takeaway:

- Total illiquid and quasi-liquid assets are projected to stay near 47% of the Plan and can be maintained near the target with no cash flow problems

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

Base Case Economic Scenario – Current Portfolio (87.5% R-S)

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

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	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Liquid Return-Seeking	40	44	44	43	42	41	41	40	40	40	41
Total Liquid	**53%**	**56%**	**57%**	**56%**	**55%**	**54%**	**53%**	**53%**	**53%**	**53%**	**53%**
Quasi-Liquid	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Illiquid: 5-10 Year Lock-up	16	14	14	15	15	15	16	16	16	15	15
Illiquid: 10+ Year Lock-up	24	22	22	22	23	23	24	24	25	24	24
Total Quasi + Illiquid	**47%**	**44%**	**43%**	**44%**	**45%**	**46%**	**47%**	**47%**	**47%**	**47%**	**47%**

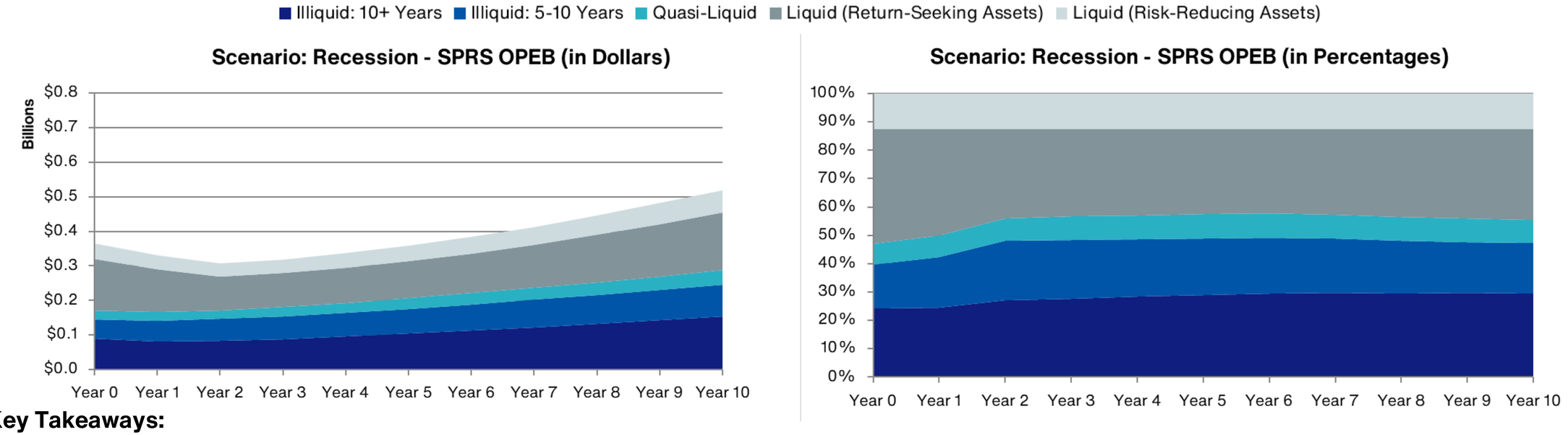
Other Metrics	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Funded Ratio (MVA / AL)	46%	52%	55%	58%	61%	65%	70%	75%	80%	86%	93%
Total Contribution Amt (in $M)	$49.6	$48.0	$47.9	$49.2	$50.9	$51.9	$52.4	$52.7	$53.1	$53.5	$54.0

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis

Recession Economic Scenario – Current Portfolio (87.5% R-S)

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



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 58% of the Plan due to shrinking market value of the total Plan in this scenario
- There would not be a concern with the ability to pay benefits
- SPRS OPEB may need to redeem some quasi-liquid and illiquid assets to stay close to its target allocation

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

Recession Economic Scenario – Current Portfolio (87.5% R-S)

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

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	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Liquid Return-Seeking	40	37	32	31	30	30	30	30	31	32	32
Total Liquid	**53%**	**50%**	**44%**	**43%**	**43%**	**42%**	**42%**	**43%**	**44%**	**44%**	**45%**
Quasi-Liquid	7%	8%	8%	8%	9%	9%	9%	8%	8%	8%	8%
Illiquid: 5-10 Year Lock-up	16	18	21	21	20	20	20	19	19	18	18
Illiquid: 10+ Year Lock-up	24	24	27	28	28	29	29	30	30	30	30
Total Quasi + Illiquid	**47%**	**50%**	**56%**	**57%**	**57%**	**58%**	**58%**	**57%**	**56%**	**56%**	**55%**

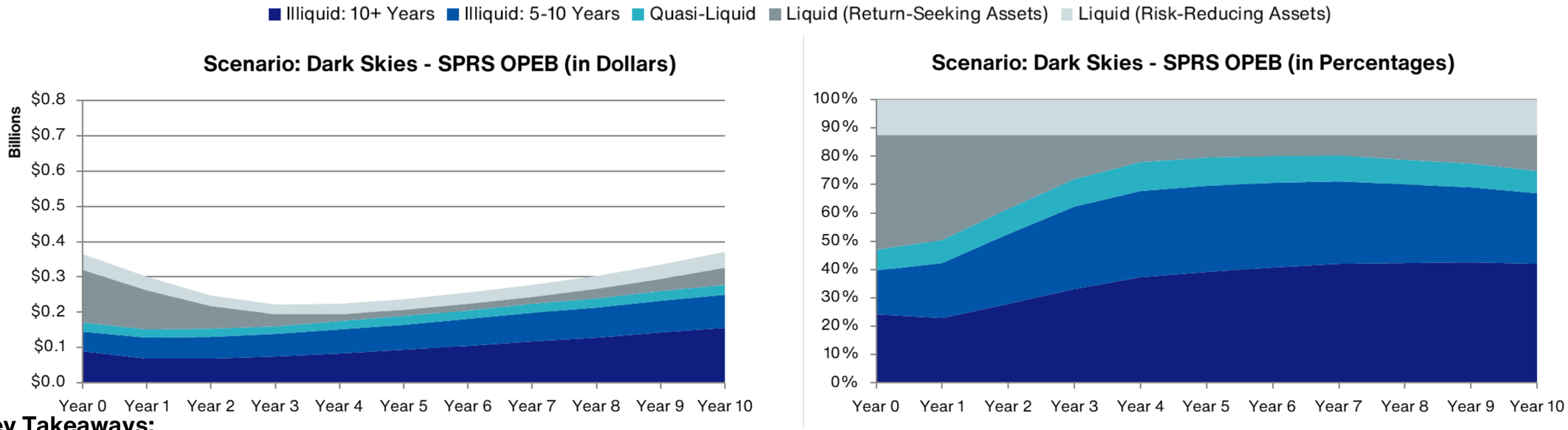
Other Metrics	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Funded Ratio (MVA / AL)	46%	41%	37%	38%	40%	43%	46%	50%	54%	60%	65%
Total Contribution Amt (in $M)	$49.6	$47.9	$47.8	$51.1	$56.2	$61.5	$66.3	$70.1	$71.4	$71.7	$71.9

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis

Dark Skies Economic Scenario – Current Portfolio (87.5% R-S)

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



Key Takeaways:

- Total illiquid and quasi-liquid assets are projected to reach as high as 80% of the Plan due to shrinking market value of the total Plan in this scenario
- SPRS OPEB would need to redeem some quasi-liquid and illiquid assets and/or pare back future commitments to stay closer to the target allocation

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

Dark Skies Economic Scenario – Current Portfolio (87.5% R-S)

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

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	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Liquid Return-Seeking	40	37	26	15	9	8	7	7	9	10	13
Total Liquid	**53%**	**50%**	**38%**	**28%**	**22%**	**20%**	**20%**	**20%**	**21%**	**23%**	**25%**
Quasi-Liquid	7%	8%	9%	10%	10%	10%	10%	9%	9%	8%	8%
Illiquid: 5-10 Year Lock-up	16	19	25	29	31	30	30	29	28	26	25
Illiquid: 10+ Year Lock-up	24	23	28	33	37	39	41	42	42	43	42
Total Quasi + Illiquid	**47%**	**50%**	**62%**	**72%**	**78%**	**80%**	**80%**	**80%**	**79%**	**77%**	**75%**

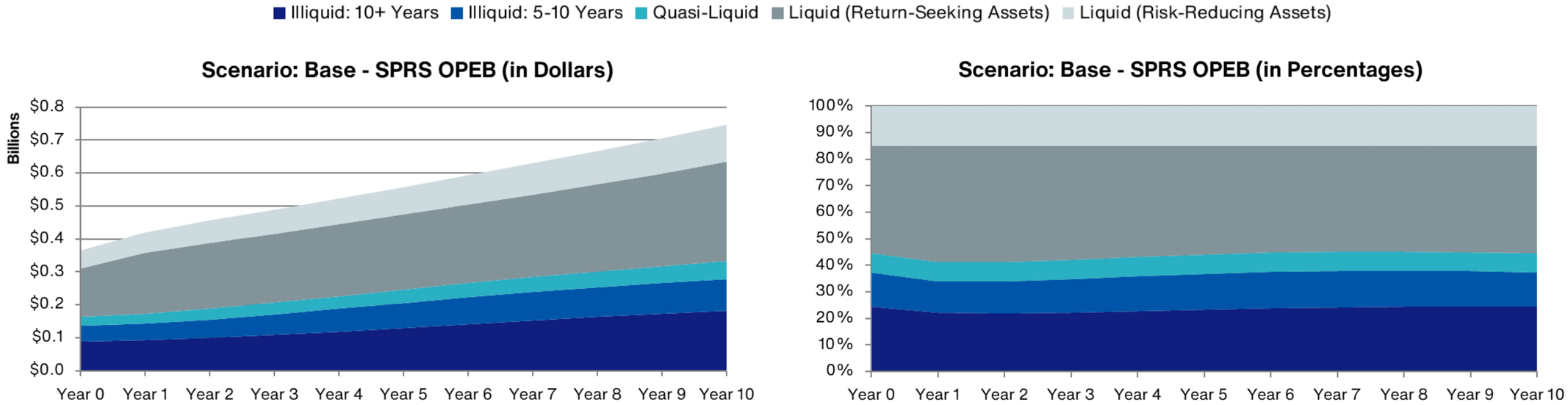
Other Metrics	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Funded Ratio (MVA / AL)	46%	37%	30%	27%	27%	29%	31%	34%	37%	42%	47%
Total Contribution Amt (in $M)	$49.6	$47.8	$47.6	$54.0	$64.6	$71.6	$74.0	$79.6	$84.4	$87.0	$88.3

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis

Base Case Economic Scenario – Alternative Portfolio (85.0% R-S)

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



Key Takeaway:

- Total illiquid and quasi-liquid assets are projected to stay near 45% of the Plan and can be maintained near the target with no cash flow problems

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

Base Case Economic Scenario – Alternative Portfolio (85.0% R-S)

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

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	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Liquid Return-Seeking	40	44	44	43	42	41	40	40	40	40	40
Total Liquid	**55%**	**59%**	**59%**	**58%**	**57%**	**56%**	**55%**	**55%**	**55%**	**55%**	**55%**
Quasi-Liquid	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Illiquid: 5-10 Year Lock-up	13	12	12	13	13	13	14	14	14	13	13
Illiquid: 10+ Year Lock-up	24	22	22	22	23	23	24	24	24	24	24
Total Quasi + Illiquid	**45%**	**41%**	**41%**	**42%**	**43%**	**44%**	**45%**	**45%**	**45%**	**45%**	**45%**

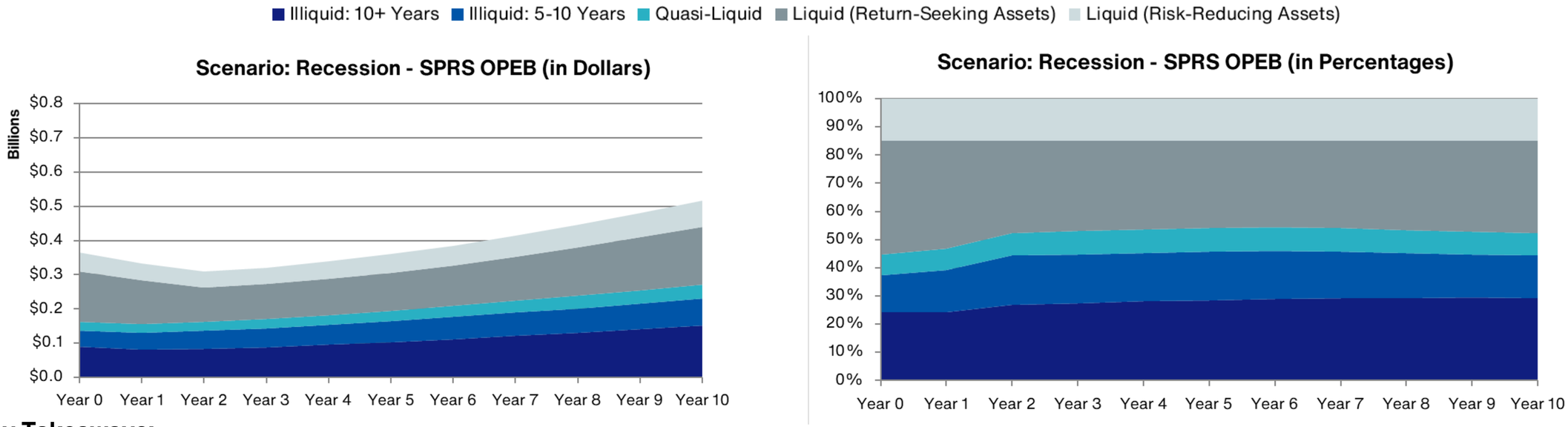
Other Metrics	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Funded Ratio (MVA / AL)	46%	52%	55%	58%	61%	65%	69%	74%	79%	85%	92%
Total Contribution Amt (in $M)	$49.6	$48.0	$47.9	$49.2	$50.6	$51.5	$52.0	$52.3	$52.7	$53.1	$53.6

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis

Recession Economic Scenario – Alternative Portfolio (85.0% R-S)

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



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 54% of the Plan due to shrinking market value of the total Plan in this scenario
- There would not be a concern with the ability to pay benefits
- SPRS OPEB may need to redeem some quasi-liquid and illiquid assets to stay close to its target allocation

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

Recession Economic Scenario – Alternative Portfolio (85.0% R-S)

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

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	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Liquid Return-Seeking	40	38	33	32	31	31	31	31	32	32	33
Total Liquid	**55%**	**53%**	**48%**	**47%**	**46%**	**46%**	**46%**	**46%**	**47%**	**47%**	**48%**
Quasi-Liquid	7%	8%	8%	8%	9%	9%	9%	8%	8%	8%	8%
Illiquid: 5-10 Year Lock-up	13	15	18	17	17	17	17	17	16	15	15
Illiquid: 10+ Year Lock-up	24	24	27	27	28	28	29	29	29	29	29
Total Quasi + Illiquid	**45%**	**47%**	**52%**	**53%**	**54%**	**54%**	**54%**	**54%**	**53%**	**53%**	**52%**

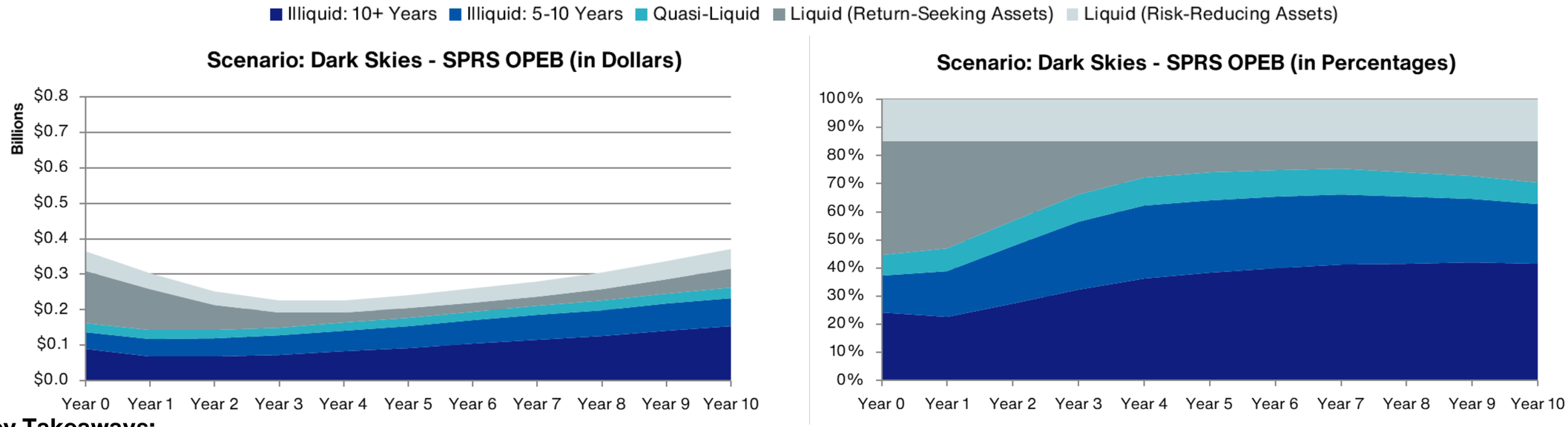
Other Metrics	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Funded Ratio (MVA / AL)	46%	41%	38%	39%	41%	43%	46%	50%	54%	60%	65%
Total Contribution Amt (in $M)	$49.6	$47.9	$47.8	$51.0	$56.0	$61.2	$66.1	$69.8	$71.1	$71.4	$71.7

Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis

Dark Skies Economic Scenario – Alternative Portfolio (85.0% R-S)

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



Key Takeaways:

- Total illiquid and quasi-liquid assets are projected to reach as high as 75% of the Plan due to shrinking market value of the total Plan in this scenario
- SPRS OPEB would need to redeem some quasi-liquid and illiquid assets and/or pare back future commitments to stay closer to the target allocation

Note: Year 0 represents a starting point of June 30, 2022

Liquidity Analysis

Dark Skies Economic Scenario – Alternative Portfolio (85.0% R-S)

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

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	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Liquid Return-Seeking	40	38	28	19	13	11	10	10	11	12	15
Total Liquid	**55%**	**53%**	**43%**	**34%**	**28%**	**26%**	**25%**	**25%**	**26%**	**27%**	**30%**
Quasi-Liquid	7%	8%	9%	10%	10%	10%	9%	9%	9%	8%	8%
Illiquid: 5-10 Year Lock-up	13	16	20	24	26	26	26	25	24	23	21
Illiquid: 10+ Year Lock-up	24	23	27	32	36	38	40	41	41	42	42
Total Quasi + Illiquid	**45%**	**47%**	**57%**	**66%**	**72%**	**74%**	**75%**	**75%**	**74%**	**73%**	**70%**

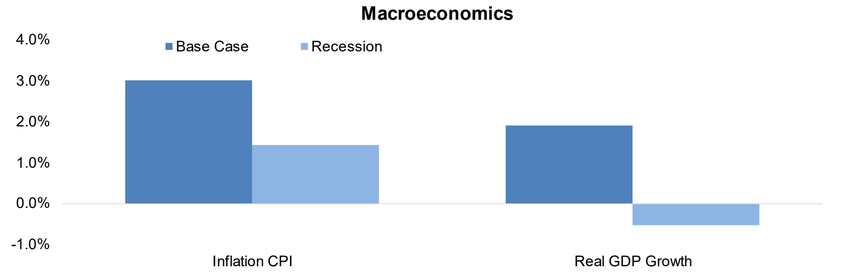
Other Metrics	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Funded Ratio (MVA / AL)	46%	38%	31%	27%	27%	29%	31%	34%	38%	42%	47%
Total Contribution Amt (in $M)	$49.6	$47.8	$47.6	$53.6	$64.0	$71.0	$73.4	$79.2	$84.1	$86.7	$88.0

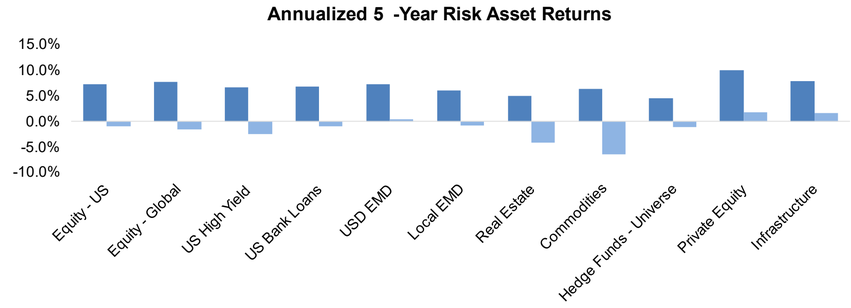
Note: Year 0 represents a starting point of June 30, 2022; Percentages may not sum to 100% due to rounding

Liquidity Analysis
Recession Scenario Description

The US economy slips back into recession in 2022/2023

- Global growth is much weaker than the base case. Concerns that inflation will remain high for longer lead to central banks rapidly tightening monetary policies.
- Tightening financial conditions, combined with spillover effects from geopolitical volatility and reduced consumer and business spending, as real incomes are squeezed by high inflation, lead to a deep recession in the US in 2022/23.
- The economic slowdown leads to developed economies implementing modest fiscal stimulus measures and monetary policy becomes more accommodative. Policy actions are only partially effective as they are tackling the demand side of the equation.
- Inflation is lower than the base case. However, inflation starts to rise in later years as the post-recession recovery gets underway.
- 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 30 June 2022
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.

Liquidity Analysis

Recession Scenario Data Table

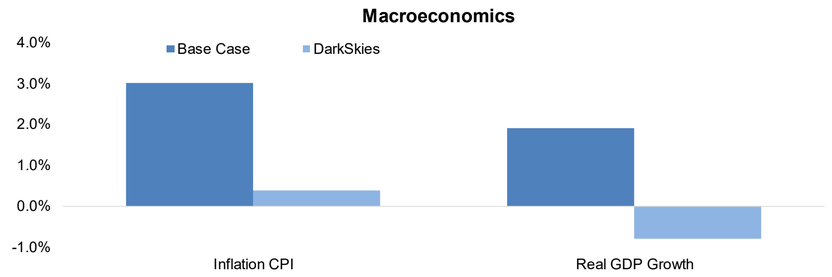
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Yields (BOY)											
Treasury yield 5y	3.0%	0.8%	0.6%	1.3%	1.6%	1.9%	1.9%	2.0%	2.1%	2.2%	2.4%
Long Treasury yield 15y	3.2%	1.0%	0.9%	1.8%	2.1%	2.4%	2.5%	2.6%	2.7%	2.8%	2.8%
TIPS yield 5y	0.6%	-1.0%	-1.1%	-0.6%	-0.5%	-0.3%	-0.3%	-0.2%	0.0%	0.2%	0.5%
Long TIPS yield 15y	1.0%	-0.7%	-0.8%	-0.2%	0.0%	0.1%	0.3%	0.4%	0.5%	0.7%	0.8%
Breakeven price inflation 15y	2.2%	1.7%	1.7%	2.0%	2.1%	2.2%	2.2%	2.2%	2.2%	2.1%	2.0%
A Corporate bond yield 5y	4.5%	5.0%	5.5%	5.5%	5.1%	5.1%	4.9%	4.7%	4.5%	4.4%	4.4%
Long A Corporate bond yield 10y	4.6%	4.5%	4.8%	5.2%	5.0%	4.9%	4.9%	5.0%	5.0%	5.1%	5.1%
A Corporate spread 5y	1.5%	4.3%	4.9%	4.2%	3.6%	3.2%	3.0%	2.7%	2.5%	2.2%	2.0%
Long A Corporate spread 10y	1.4%	3.6%	4.1%	3.7%	3.2%	3.0%	2.8%	2.6%	2.4%	2.3%	2.1%
Expected nominal return on assets											
Equity – US		-17.2%	-9.1%	11.5%	6.6%	6.6%	6.7%	6.7%	6.8%	6.9%	6.9%
Equity – Global		-19.6%	-10.5%	12.5%	7.0%	7.0%	7.0%	7.1%	7.2%	7.2%	7.3%
A Corporate bonds 5y		2.1%	1.4%	3.3%	5.4%	4.2%	4.8%	4.7%	4.5%	4.3%	4.2%
Long A Corporate bonds 10y		3.7%	-1.1%	-1.7%	5.6%	3.2%	3.5%	3.9%	4.1%	4.6%	4.8%
Treasury 5y		13.1%	1.7%	-1.6%	0.5%	0.9%	2.1%	2.1%	2.0%	2.0%	1.9%
Long Treasury 15y		40.3%	3.9%	-10.5%	-0.3%	-0.5%	1.8%	2.0%	2.2%	2.3%	2.1%
TIPS 5y		9.9%	1.0%	-1.7%	0.1%	0.4%	1.0%	1.1%	1.1%	1.2%	1.4%
Long TIPS 15y		32.4%	2.6%	-7.6%	0.0%	0.0%	0.8%	0.9%	1.0%	0.9%	1.1%
US High Yield		-15.3%	-11.8%	7.2%	5.4%	4.0%	5.4%	5.4%	5.3%	5.4%	5.3%
Bank Loans		-10.2%	-7.1%	6.3%	3.7%	3.6%	3.9%	4.2%	4.5%	4.7%	4.9%
USD Emerging Market Debt		-11.2%	-6.9%	9.2%	6.4%	6.2%	6.7%	6.7%	6.7%	6.7%	6.7%
Local Emerging Market Debt		-12.4%	-8.1%	8.0%	5.3%	5.0%	5.5%	5.5%	5.5%	5.5%	5.5%
Real Estate		-13.2%	-8.1%	-3.0%	0.5%	4.4%	4.4%	4.5%	4.6%	4.6%	4.7%
Commodities		-26.0%	-20.1%	8.9%	5.5%	5.5%	5.6%	5.6%	5.7%	5.8%	5.9%
Hedge Funds - FoHF – Universe		-13.4%	-8.2%	7.4%	6.2%	4.4%	4.5%	4.5%	4.5%	4.5%	4.5%
Private Equity		-19.8%	-9.9%	14.7%	9.2%	9.2%	9.2%	9.3%	9.4%	9.5%	9.5%
Infrastructure - US		-4.9%	-0.6%	2.9%	3.7%	7.3%	7.4%	7.4%	7.5%	7.5%	7.5%
Cash		2.8%	0.3%	0.4%	0.8%	1.1%	1.2%	1.4%	1.6%	1.7%	1.8%
CPI		2.4%	1.5%	0.8%	1.1%	1.4%	1.5%	1.6%	1.7%	1.8%	1.9%

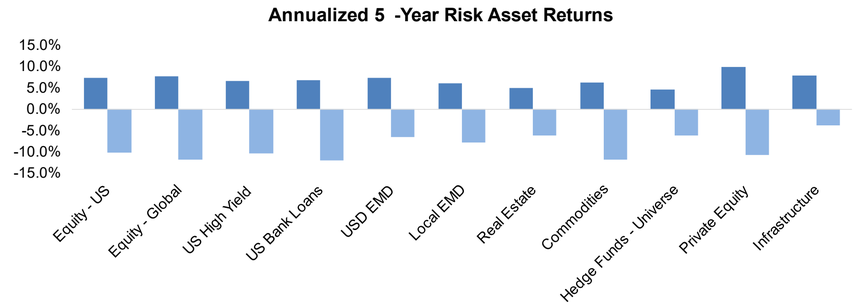
Scenario information as of June 30, 2022

Liquidity Analysis
Dark Skies Scenario Description

A deep recession followed by a longer period of stagnant growth

- A worsening Russia-Ukraine war, which expands beyond Ukraine's borders, and a renewed flare up of the pandemic, disrupts to the global economy, as additional restrictions are required over the next few years. China experiences a sharp deterioration in economic growth, due to stricter Covid restrictions and structural issues.
- Worsening geopolitical instability and central banks' aggressive monetary tightening has a severe impact on world economic growth. 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.
- Inflation falls sharply in 2022 and sluggish growth over the following years means that inflation stays low.
- 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 30 June 2022
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.

Liquidity Analysis

Dark Skies Scenario Data Table

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Yields (BOY)											
Treasury yield 5y	3.0%	0.2%	-0.6%	-0.7%	-0.7%	-0.5%	-0.2%	0.0%	0.3%	0.6%	0.9%
Long Treasury yield 15y	3.2%	0.4%	-0.1%	-0.2%	-0.1%	0.0%	0.3%	0.6%	0.9%	1.2%	1.4%
TIPS yield 5y	0.6%	-1.1%	-1.7%	-1.9%	-1.8%	-1.7%	-1.5%	-1.3%	-1.1%	-0.8%	-0.4%
Long TIPS yield 15y	1.0%	-1.1%	-1.5%	-1.6%	-1.5%	-1.4%	-1.2%	-0.9%	-0.7%	-0.4%	-0.2%
Breakeven price inflation 15y	2.2%	1.5%	1.4%	1.4%	1.4%	1.4%	1.5%	1.6%	1.6%	1.6%	1.6%
A Corporate bond yield 5y	4.5%	5.8%	5.6%	5.2%	4.6%	4.3%	4.2%	4.1%	4.1%	4.0%	4.0%
Long A Corporate bond yield 10y	4.6%	4.9%	4.8%	4.5%	4.1%	3.9%	4.0%	4.1%	4.2%	4.3%	4.4%
A Corporate spread 5y	1.5%	5.6%	6.2%	5.9%	5.2%	4.8%	4.4%	4.1%	3.8%	3.4%	3.1%
Long A Corporate spread 10y	1.4%	4.6%	5.0%	4.8%	4.4%	4.0%	3.8%	3.6%	3.3%	3.1%	2.9%
Expected nominal return on assets											
Equity – US		-26.2%	-18.6%	-9.8%	3.7%	3.7%	4.0%	4.4%	4.7%	5.1%	5.5%
Equity – Global		-29.5%	-21.0%	-11.1%	3.7%	3.7%	4.1%	4.5%	4.9%	5.3%	5.7%
A Corporate bonds 5y		-1.9%	1.7%	1.5%	2.2%	0.9%	0.3%	0.8%	1.2%	1.6%	1.9%
Long A Corporate bonds 10y		-1.0%	0.4%	1.8%	3.1%	1.1%	-0.4%	0.2%	0.7%	1.3%	1.8%
Treasury 5y		15.5%	3.6%	-0.4%	-1.0%	-1.4%	-1.8%	-1.5%	-1.2%	-1.0%	-0.7%
Long Treasury 15y		52.5%	8.9%	1.7%	-0.3%	-1.5%	-3.2%	-2.8%	-2.5%	-2.1%	-2.0%
TIPS 5y		8.8%	1.2%	-1.3%	-2.0%	-2.1%	-2.0%	-1.7%	-1.4%	-1.1%	-0.7%
Long TIPS 15y		37.0%	4.8%	-0.1%	-2.1%	-2.4%	-3.6%	-3.2%	-3.0%	-2.7%	-2.4%
US High Yield		-19.6%	-15.2%	-11.2%	-1.6%	-2.9%	-3.1%	-2.1%	-1.1%	-0.2%	0.6%
Bank Loans		-23.3%	-19.9%	-12.5%	-0.8%	-1.1%	-0.5%	0.2%	0.9%	1.6%	2.2%
USD Emerging Market Debt		-17.2%	-12.4%	-6.9%	2.9%	2.4%	2.4%	2.9%	3.4%	3.8%	4.3%
Local Emerging Market Debt		-18.4%	-13.6%	-8.0%	1.8%	1.2%	1.2%	1.7%	2.2%	2.7%	3.1%
Real Estate		-14.9%	-10.5%	-4.9%	-0.6%	1.5%	1.9%	2.2%	2.6%	2.9%	3.2%
Commodities		-33.1%	-25.1%	-1.6%	4.1%	4.1%	4.3%	4.5%	4.7%	5.0%	5.2%
Hedge Funds - FoHF – Universe		-16.3%	-11.1%	-5.5%	1.5%	1.5%	1.8%	2.1%	2.4%	2.7%	3.0%
Private Equity		-30.6%	-21.4%	-10.5%	5.6%	5.6%	6.0%	6.5%	6.9%	7.3%	7.8%
Infrastructure - US		-11.8%	-7.5%	-3.7%	1.3%	3.9%	4.3%	4.7%	5.0%	5.4%	5.8%
Cash		2.8%	-0.1%	-0.5%	-0.6%	-0.5%	-0.3%	-0.1%	0.2%	0.4%	0.7%
CPI		1.0%	-0.2%	0.2%	0.4%	0.6%	0.8%	0.9%	1.1%	1.3%	1.5%

Scenario information as of June 30, 2022

How Do Public Pensions Impact Credit Ratings?

Section 4: Appendix

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 (Fitch, Moody's and S&P) 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 the 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
1. **Conduct an actuarial assumption audit** Review reasonability of key assumptions: • Salary scale, Mortality, Retirement rates, Turnover rates	• Assumptions set to plan-specific expectations will lead to lower contribution volatility • Aggressive assumptions may provide short-term relief but may have long-term consequences
2. **Consider adjustments to expected return assumption** Adjustments should be in line with forward-looking expectations for asset returns	• Contributing an actuarial amount? – 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 volatile – No: The funding gap will widen and become highly volatile as contribution policy will not add enough dollars to replenish losses
3. **Review the plan's funding policy** Look far enough into the future to identify potential pain points	• Conduct "tread water"/hurdle rate analysis to ensure short-term contributions are sufficient to keep pace with growth of plan liabilities • Consider asset-liability study to understand range of potential future outcomes rather than a single deterministic scenario

Asset-Liability Management Background

Section 4: Appendix

Ultimate Retirement Benefit Cost Equation

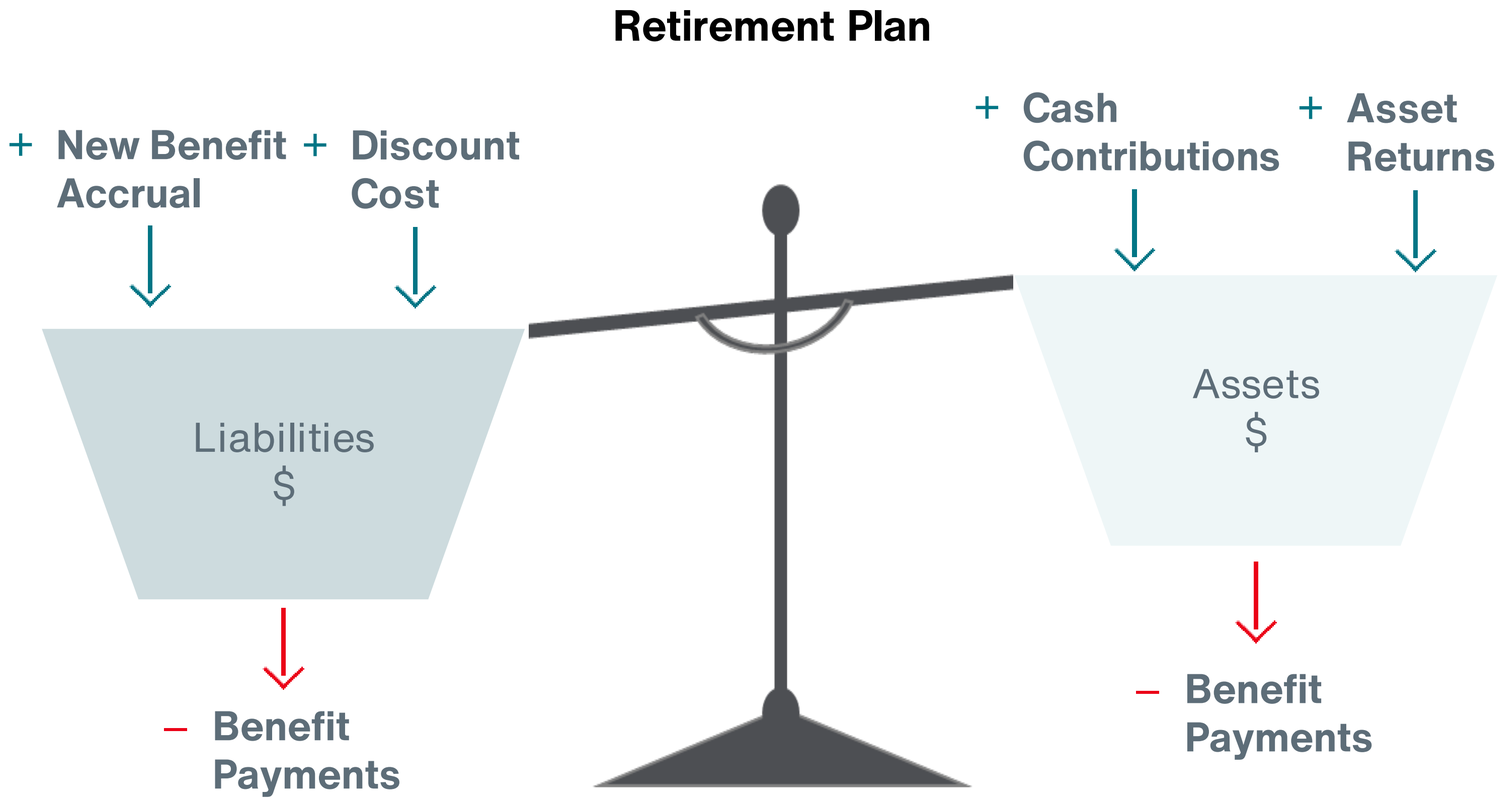
The cost ultimately borne by the Plan will be represented by the financing equation shown below:

The asset-liability study will analyze the variability of future investment returns on the Plan financials

Higher than expected returns will result in lower future Plan costs

Lower than expected returns will result in higher future Plan costs

Balance of Liabilities and Assets



Key Takeaways:

Plan Liabilities will grow in two ways:

- New benefit accruals (or Normal Cost)
- One less year of interest discounting (or Discount Cost)

Assets will grow in two ways:

- Cash Contributions to the Plan
- Asset Returns

Both liabilities and assets will be reduced by benefits paid to participants

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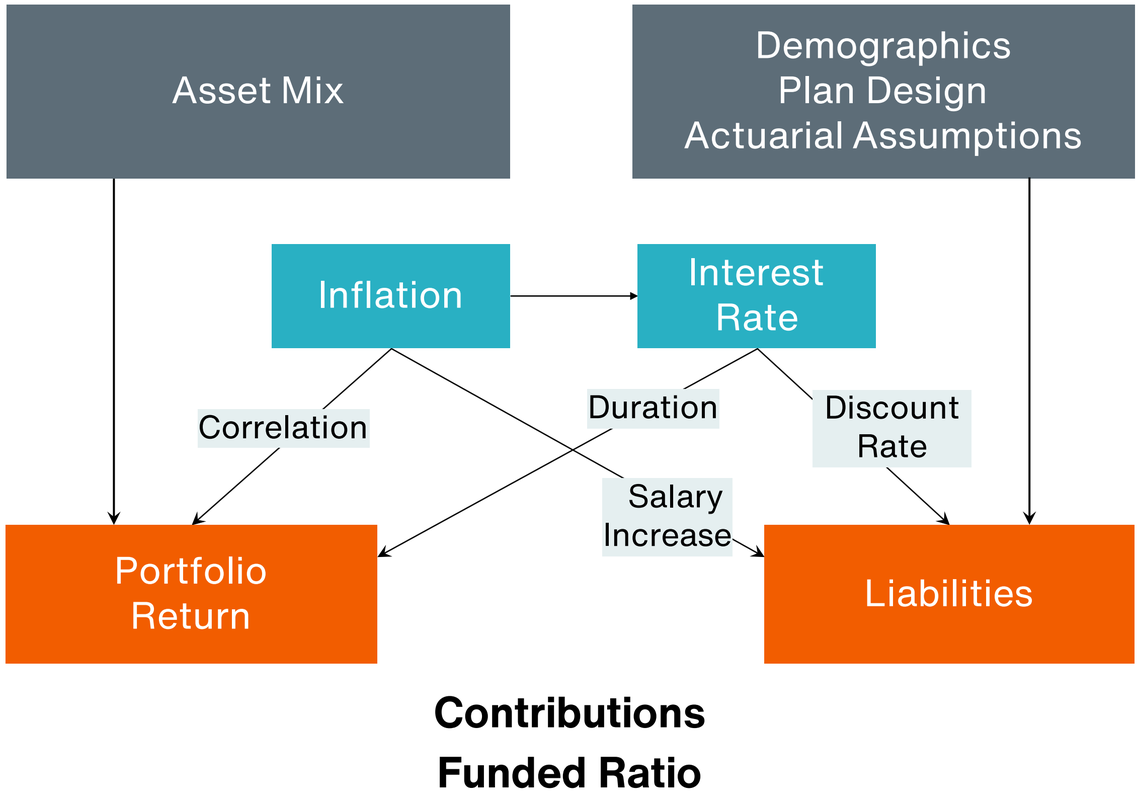
Mechanics of Asset-Liability Modeling Process



Key Features

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

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 needs to increase or funded status declines (e.g., stocks decline, inflation/deflation shocks and/or interest rates decline)

Key Factors Affecting the Risk/Reward Trade-off

The key take-away from the asset-liability 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

Limitations of Asset-Liability Modeling

Asset-liability studies are best-suited to determine the optimal mix of return-seeking (e.g., equity) and risk-reducing (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

AON

Glossary of Terms

Section 4: Appendix

Glossary of Terms

AVA – Actuarial value of assets (i.e., incorporates smoothing of gains and losses)

Asset Growth Rate or "Hurdle Rate" – The required rate of growth of the assets (through both contributions and investment returns) to keep pace with the growth of the liability

Current Frontier – Uses SPRS' mix of asset classes within the return-seeking allocation, then dials the return-seeking allocation up and down from 0% to 100% to illustrate forecasted returns at various return-seeking / safety asset mixes

Economic Cost – Present value of forecasted future contributions + present value of funding shortfall/(surplus) at the end of the projection period

Liability Growth Rate – The projected growth of the liability over the coming year as measured by the sum of the normal cost (new benefit accruals) and discount/interest cost (one less year of discounting at the time value of money)

MVA – Market value of assets (i.e., un-smoothed/economic reality)

Return-Seeking Assets ("R-S") – All non "safety" assets

Safety Assets – Assets where the primary function is risk control/downside mitigation.

Target Asset Allocation – The allocation of assets between return-seeking assets and safety assets

About This Material

Section 4: Appendix

About This Material

This material includes a summary of calculations and consulting related to the finances of the Michigan State Police Retiree Health Benefits (SPRS OPEB). The following variables have been addressed:

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

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 SPRS OPEB. 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 2021/2022 fiscal year actuarial valuation for SPRS OPEB 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 September 30, 2021. Reflecting events after September 30, 2021 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 SPRS OPEB has any direct financial interest or indirect material interest in SPRS OPEB. Thus, we believe there is no relationship existing that might affect our capacity to prepare and certify this report for SPRS OPEB.

Aon Investments USA Inc.

Phil Kivarkis FSA, CFA

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