Asset-Liability Study Results

Pennsylvania Public School Employees' Retirement System (PSERS)
September 15, 2017

Aon Hewitt
Retirement and Investment

Empower Results®

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- Long-Term Target portfolio is well-diversified
- The expected return for the Long-Term Target portfolio is 7.20% over the next 30 years
- PSERS should consider its desired balance between funding and investment returns in order to determine the ideal investment portfolio

Asset-Liability Projection Analysis

- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- The Long-Term Target portfolio has a 55% chance of attaining a fully funded status over the 30 year projection period
- Higher return-seeking strategies trend more quickly to full funding but with greater risk
- Adverse market or funding experience could significantly impact the funded status of the Plan over the projection period

Executive Summary
Key Observations

1) Similar to last year's analysis, PSERS is projected to attain full funding by 2040 (on a market value of assets basis) in our central expectation (50th percentile outcome) under the Long-Term Target Asset Allocation

- This assumes that the actuarially determined contributions are paid in full when they are due
- These projections include the benefit changes from Act 5 of 2017

2) PSERS gross contributions are expected to increase in the central expectation over the next twenty years to approximately $9.5 billion annually utilizing the Long-Term Target, Clean Slate or Less Illiquids allocations

- This increase in contributions reflects the amortization of the $42.7 billion in unfunded liabilities as of June 30, 2016, based on the current amortization schedule
- The contributions decline to $2.5 billion (the normal cost) at the end of the 30-year projection period as the plan reaches 100% funded

3) The Long-Term Target portfolio has a higher expected return (0.07%-0.88%) with meaningfully lower risk (0.32%-0.54%) than the Less Illiquids and 60/40 Portfolios which have lower manager fees

- The higher return generated by the use of actively managed alternatives and the diversifying benefits of the much broader asset allocation are a significant benefit even after the inclusion of the higher manager fees associated with these strategies

Executive Summary
Key Observations (continued)

4) The Proposed 1-Year Target portfolio represents modest enhancements of the risk/return characteristics versus the Current 1-Year Target portfolio and provide PSERS with slightly higher risk-adjusted returns as measured by the Sharpe ratio

- The Proposed portfolio further diversifies the fixed income portfolio with greater use of Private High Yield which provides higher returns and greater diversification
- While illiquid, the time horizon for Private High Yield funds is shorter than the Private Equity and Private Real Estate allocations which are both reduced slightly versus the Current 1-Year Target

5) Liquidity needs remain noteworthy, but largely manageable and sufficiently met by the Long-Term Target and future contributions

- Only the “Black Skies” scenario appears to significantly stress the fund’s liquidity over the next ten years; all other scenarios do not represent a liquidity risk to PSERS
- This assumes that the actuarially-determined contributions are paid in full when they are due
- These projections include the benefit changes from Act 5 of 2017

6) The analysis of the Proposed 1-Year Target and the Current Long-Term Target portfolios support that the 7.25% Expected Return on Assets assumption is reasonable for the given level of risk

- The modeled returns do not include any assumption for alpha produced from active management in the public market asset classes
- Given PSERS current portfolio structure which utilizes a fair degree of active management, AHIC believes a 15-25 bps additional alpha assumption is reasonable

Executive Summary
Current State

- As of the June 30, 2016 actuarial valuation, the Pennsylvania Public School Employees' Retirement System (PSERS) has the following asset-liability profile:

	Pennsylvania Public School Employees' Retirement System
Market Value of Assets (MVA)	$49.8B
Actuarial Value of Assets (AVA)	$57.3B
Actuarial Liabilities	$100.0B
Funded Status (based on MVA)	49.8%
Funded Status (based on AVA)	57.3%
Actuarial Assumed Rate of Return	7.25%
Liability Growth Rate	9.4%
Required Asset Growth Rate[1]	18.8%

- PSERS' current long-term target asset allocation policy is 91% return-seeking / 29% safety assets (inclusive of a 20% leveraged position)
- The following analysis assumes
  - Provisions of Act 5 of 2017, Retirement Code Legislation
  - The actuarially-determined contributions will be made to the Plan each year

[1] The growth rate required of the assets to keep pace with the liability growth
Health care premium assistance assets and liabilities have not been included in this analysis

Executive Summary

Act 5 of 2017, Retirement Code Legislation

- Act 5 was passed on June 12, 2017 establishing new pension plan design options for most future members of PSERS effective July 1, 2019.
  - A summary of the options is below:

	Hybrid Plan: Class T-G Membership	Hybrid Plan: Class T-H Membership	DC Only Plan
Defined Benefit Multiplier	1.25%	1.00%	N/A
Employee Contributions	8.25%	7.50%	7.50%
- For DB Plan	5.50%	4.50%	N/A
- For DC Plan	2.75%	3.00%	7.50%
Employer Contributions			
- For DB Plan	Actuarially-Determined	Actuarially-Determined	N/A
- For DC Plan	2.25%	2.00%	2.00%
Future Participation Assumption	65%	30%	5%

  - An additional provision related to pension funding requires the 10 year asset averaging method to be constrained to remain within a 30% corridor of the market value of assets

- Because the benefit reforms impact future members, the liability changes will be minimal in the near-term and gradually grow over time, depending on the actual participant election percentages

Executive Summary
Portfolios Evaluated

	1-Year Target Portfolios		Long-Term Portfolios Tested in Asset-Liability Modeling				
	Current Target	Proposed Target	Current Long-Term Target	Clean Slate	Less Illiquids	60/40	Low Risk
Cash	3.0%	3.0%	3.0%	0.0%	3.0%	0.0%	3.0%
LIBOR (Leverage)	-17.0%	-17.0%	-20.0%	-25.0%	-17.0%	0.0%	0.0%
Total Cash	**-14.0%**	**-14.0%**	**-17.0%**	**-25.0%**	**-14.0%**	**0.0%**	**3.0%**
US Large Cap	6.3%	6.3%	6.6%	10.1%	9.3%	19.9%	4.6%
US Small Cap	1.1%	1.1%	1.2%	1.8%	1.6%	3.5%	0.9%
Intl. Developed Equity[1]	8.6%	8.6%	9.4%	14.2%	13.2%	28.2%	6.6%
Emerging Mkt. Equity	3.0%	3.0%	2.8%	4.3%	3.9%	8.4%	1.9%
Private Equity	16.0%	15.0%	15.0%	8.9%	11.0%	0.0%	11.0%
Total Equities	**35.0%**	**34.0%**	**35.0%**	**39.3%**	**39.0%**	**60.0%**	**25.0%**
Core Fixed Income	5.0%	5.0%	5.0%	11.9%	5.0%	40.0%	5.0%
Long Govt Bonds	3.0%	3.0%	5.0%	23.8%	5.0%	0.0%	6.0%
High Yield Bonds	1.6%	0.0%	1.6%	1.3%	1.6%	0.0%	1.2%
Private Debt (2X Levered)	6.4%	10.0%	6.4%	5.5%	6.4%	0.0%	4.8%
Non-US Developed Bonds[2]	1.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%
EMD Hard	0.5%	0.0%	1.0%	3.3%	1.0%	0.0%	0.5%
EMD Local	0.5%	1.0%	1.0%	3.3%	1.0%	0.0%	0.5%
Global Inflation-Linked[3]	15.0%	15.0%	15.0%	0.0%	13.0%	0.0%	20.0%
Total Fixed Income	**33.0%**	**35.0%**	**36.0%**	**49.1%**	**34.0%**	**40.0%**	**39.0%**
Private Real Estate	11.0%	10.0%	8.0%	8.6%	9.0%	0.0%	6.0%
REITs	1.0%	1.0%	2.0%	1.9%	3.0%	0.0%	1.0%
Commodities	5.0%	5.0%	5.0%	1.4%	5.0%	0.0%	3.8%
Timberland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Private Infrastructure	2.0%	1.0%	4.0%	1.5%	0.0%	0.0%	2.0%
Public Infrastructure	4.0%	5.0%	4.0%	0.0%	3.0%	0.0%	4.0%
Gold	3.0%	3.0%	3.0%	0.0%	3.0%	0.0%	2.3%
Total Real Assets	**26.0%**	**25.0%**	**26.0%**	**13.4%**	**23.0%**	**0.0%**	**19.0%**
Risk Parity[4]	**10.0%**	**10.0%**	**10.0%**	**5.8%**	**10.0%**	**0.0%**	**7.0%**
Hedge Funds[5]	**10.0%**	**10.0%**	**10.0%**	**17.4%**	**8.0%**	**0.0%**	**7.0%**
Total Plan	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
30-Year Expected Nominal Return	**7.15%**	**7.29%**	**7.20%**	**7.18%**	**7.13%**	**6.32%**	**6.21%**
30-Year Expected Real Return	**4.88%**	**5.01%**	**4.93%**	**4.90%**	**4.85%**	**4.05%**	**3.95%**
30-Year Expected Risk	**10.85%**	**10.91%**	**10.90%**	**10.88%**	**11.22%**	**11.44%**	**7.97%**
Sharpe Ratio	**0.402**	**0.411**	**0.404**	**0.403**	**0.386**	**0.308**	**0.427**
% Illiquids	**45.4%**	**46.0%**	**43.4%**	**41.9%**	**34.4%**	**0.0%**	**30.8%**

[1] Hedged to USD

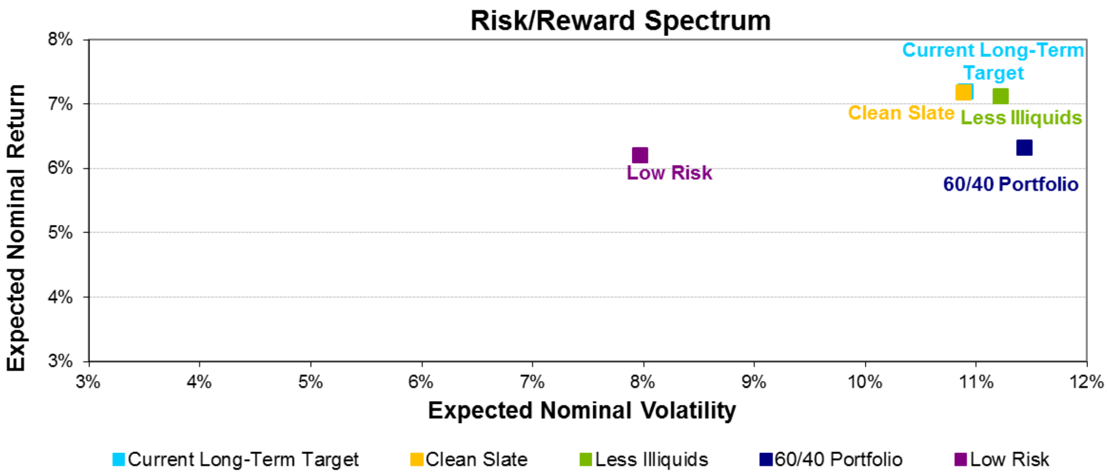
[2] Hedged to USD

[3] 40% US, 2% Canada, 31% UK, 27% Europe. Hedged to USD.

[4] 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate US Govt. Bonds, 20% Commodities

[5] 16% Event Driven, 0% CTA, 38% Global Macro, 0% Distressed Debt, 37% Fixed Income Arbitrage, 9% Cat. Bonds

Executive Summary
30-Year Capital Market Assumptions



Key Takeaways:

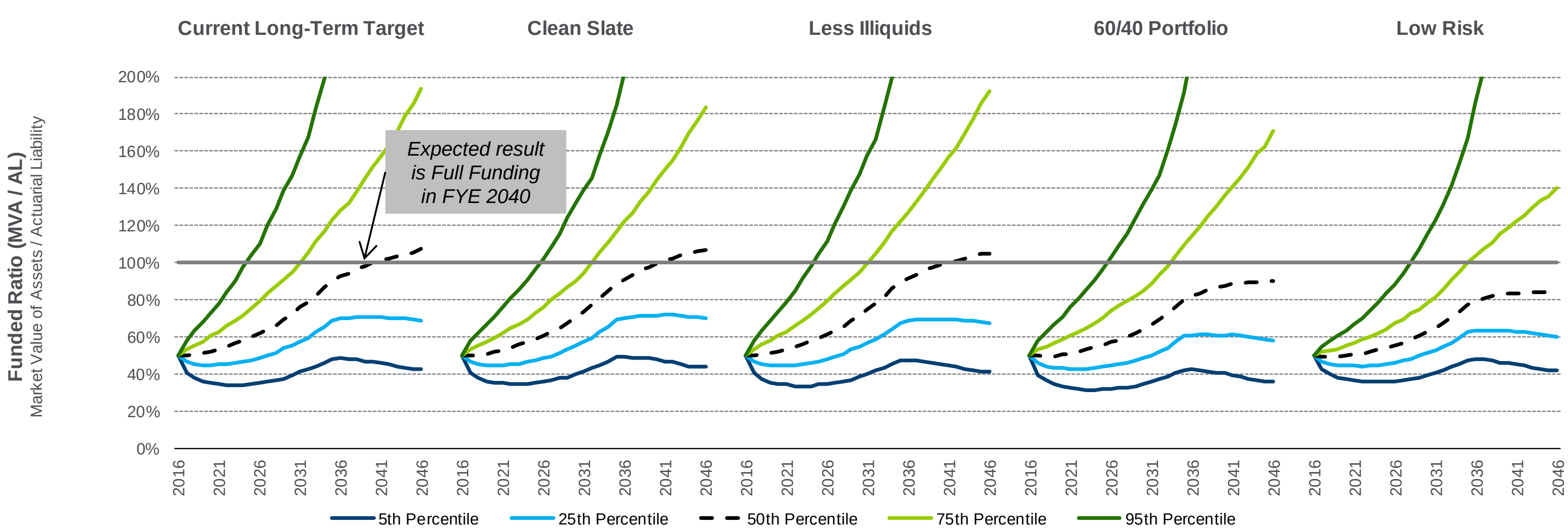
- The Current Long-Term Target portfolio has a high allocation to return-seeking assets
  - Return-seeking assets are broadly diversified
- The Current Long-Term Target portfolio includes a leveraged position of 20%

Portfolio Weights

				Equity Returns	Diversified Returns				Skill				Safety					
	Exp. Nom. Return	Exp. Nom. Vol.	Sharpe Ratio	Global Equity	High Yield Bonds / Private Debt	Emerg. Market Debt	Real Estate	Comm-odities	Hedge Funds	Risk Parity	Private Equity	Infra-structure	Global TIPS	Cash	Core Bonds	Long Dur. Gov't Bonds	Dev. Int'l Debt	Lever-aged
Current Long-Term Target	7.20%	10.90%	0.404	20%	8%	2%	10%	8%	10%	10%	15%	8%	15%	3%	5%	5%	1%	-20%
Clean Slate	7.18%	10.88%	0.403	30%	7%	7%	11%	1%	17%	6%	9%	2%	0%	0%	12%	24%	0%	-25%
Less Illiquids	7.13%	11.22%	0.386	28%	8%	2%	12%	8%	8%	10%	11%	3%	13%	3%	5%	5%	1%	-17%
60/40 Portfolio	6.32%	11.44%	0.308	60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%	0%	0%
Low Risk	6.21%	7.97%	0.427	14%	6%	1%	7%	6%	7%	7%	11%	6%	20%	3%	5%	6%	1%	0%

Executive Summary

Stochastic Projections (Market Value of Assets / Actuarial Liability Funded Ratio)



Strategy	Current Long-Term Target			Clean Slate			Less Illiquids			60/40 Portfolio			Low Risk		
Year	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**
5th Percentile	35%	49%	43%	36%	50%	44%	35%	48%	41%	32%	42%	36%	36%	48%	42%
25th Percentile	49%	70%	69%	48%	70%	70%	48%	68%	68%	44%	61%	58%	46%	63%	60%
50th Percentile	62%	93%	107%	61%	91%	107%	62%	92%	105%	57%	82%	90%	56%	79%	84%
75th Percentile	79%	128%	193%	76%	122%	183%	79%	127%	192%	74%	114%	171%	67%	104%	140%
95th Percentile	110%	238%	672%	102%	202%	510%	111%	243%	679%	103%	213%	630%	88%	186%	478%
Probability > 100%	12%	45%	55%	7%	43%	55%	12%	44%	53%	7%	36%	47%	<5%	29%	43%

Key Takeaways:

- The funded ratio is projected to trend toward full funding over the course of the projection period
- Adverse market experience could significantly impact the funded status of the Plan

* Liability projections assume discount rates of 7.25% for all investment policies studied

Executive Summary
Short-Term Funded Ratio Shortfall Analysis (Based on Market Value of Assets)

After five (5) years, PSERS is projected to have the following probability of surpassing key funded ratio thresholds:

Probability of Surpassing Various Funded Ratio Thresholds					
Funded Ratio	**Current Long-Term Target**	**Clean Slate**	**Less Illiquids**	**60/40 Portfolio**	**Low Risk**
90%	1.1%	0.6%	**1.3%**	0.7%	**0.0%**
80%	3.9%	2.8%	**4.3%**	2.8%	**0.4%**
70%	12.7%	10.1%	**13.2%**	9.6%	**2.6%**
60%	31.8%	29.3%	**32.2%**	26.8%	**15.8%**
50%	**61.2%**	59.6%	60.0%	52.6%	**51.5%**
40%	87.0%	87.2%	86.0%	**82.2%**	**88.8%**
30%	98.4%	98.4%	98.1%	**97.3%**	**99.7%**
20%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Green = Portfolio with the highest probability of surpassing a given threshold

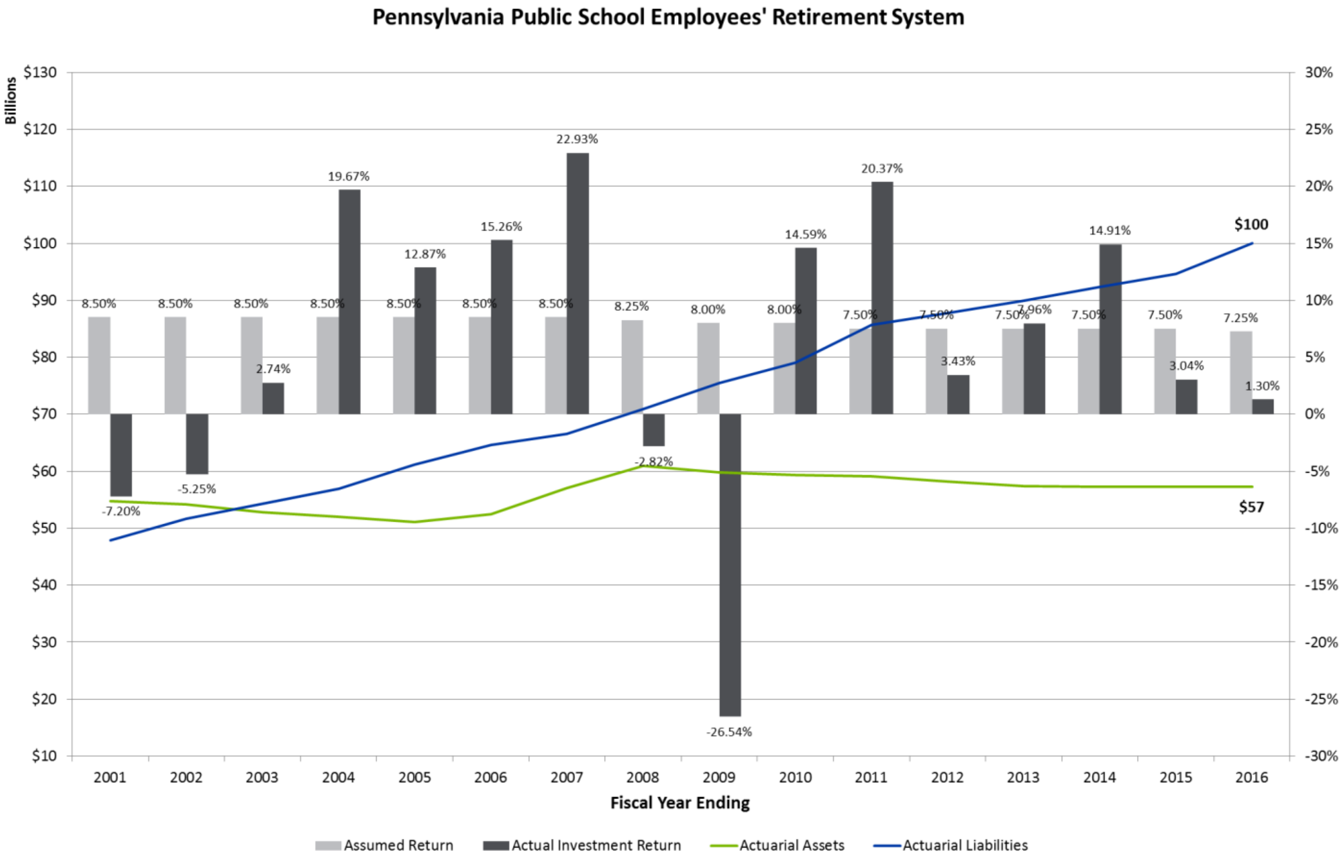
Red = Portfolio with the lowest probability of surpassing a given threshold

Key Takeaway:

- Higher risk portfolios will have more upside potential while lower risk portfolios will have higher downside protection

Background & Current State

Background and Historical Information



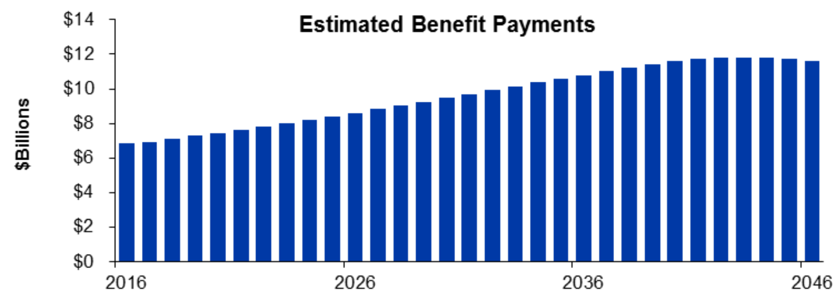
Key Takeaways:

- **Blue line** represents the actuarial liabilities over time
  - Adding to the increase in liability has been the decrease in the assumed investment return (**light gray bar**)
- **Green line** represents the actuarial value of plan assets over time
  - Assets reflect smoothing parameters to the actual return on assets (**dark gray bar**)

Sources: Public Plans Data (publicplansdata.org) as of July 2017

Current State Asset-Liability Profile
As of June 30, 2016

Asset-Liability Snapshot as of 6/30/2016		
Metric ($, Billions)	**Value**	**Fund %**
Market Value of Assets	$49.8	49.8%
Actuarial Value of Assets	$57.3	57.3%
Liability Metrics		
Actuarial Liability (AL) - Funding	$100.0[1]	



Asset-Liability Growth Metrics			
Metric ($, Billions)	**Value**	**% Liability**	**% Assets**
AL Discount Cost	$7.3	7.3%	14.5%
AL Normal Cost	$2.1	2.1%	4.3%
Total Liability Hurdle Rate	**$9.4**	**9.4%**	**18.8%**
Expected Return on Assets	$3.6	3.6%	7.3%
ER + EE Contributions	$5.0	5.0%	10.0%
Total Exp. Asset Growth	**$8.6**	**8.6%**	**17.3%**
Hurdle Rate Shortfall[2]	**$0.8**	**0.8%**	**1.6%**
Est. Benefit Payments	$6.8	6.8%	13.7%

Long-Term Target Asset Allocation as of 6/30/2016		
Metric ($, Billions)	**Value**	**Alloc %**
Return-Seeking		
- Global Equity	$10.0	20%
- Private Equity	$7.5	15%
- Real Estate	$5.0	10%
- Hedge Funds	$5.0	10%
- Risk Parity	$5.0	10%
- Commodities	$4.0	8%
- Infrastructure	$4.0	8%
- High Yield Bonds	$4.0	8%
- Emerging Market Debt	$1.0	2%
- Total	$45.3	91%
Risk-Reducing		
- Cash[3]	-$8.5	-17%
- Global TIPS	$7.5	15%
- Core Bonds	$2.5	5%
- Long Duration Gov't Bonds	$2.5	5%
- Developed International Debt	$0.5	1%
- Total	$4.5	9%
Total	$49.8	100%

Health care premium assistance assets and liabilities have not been included in this analysis

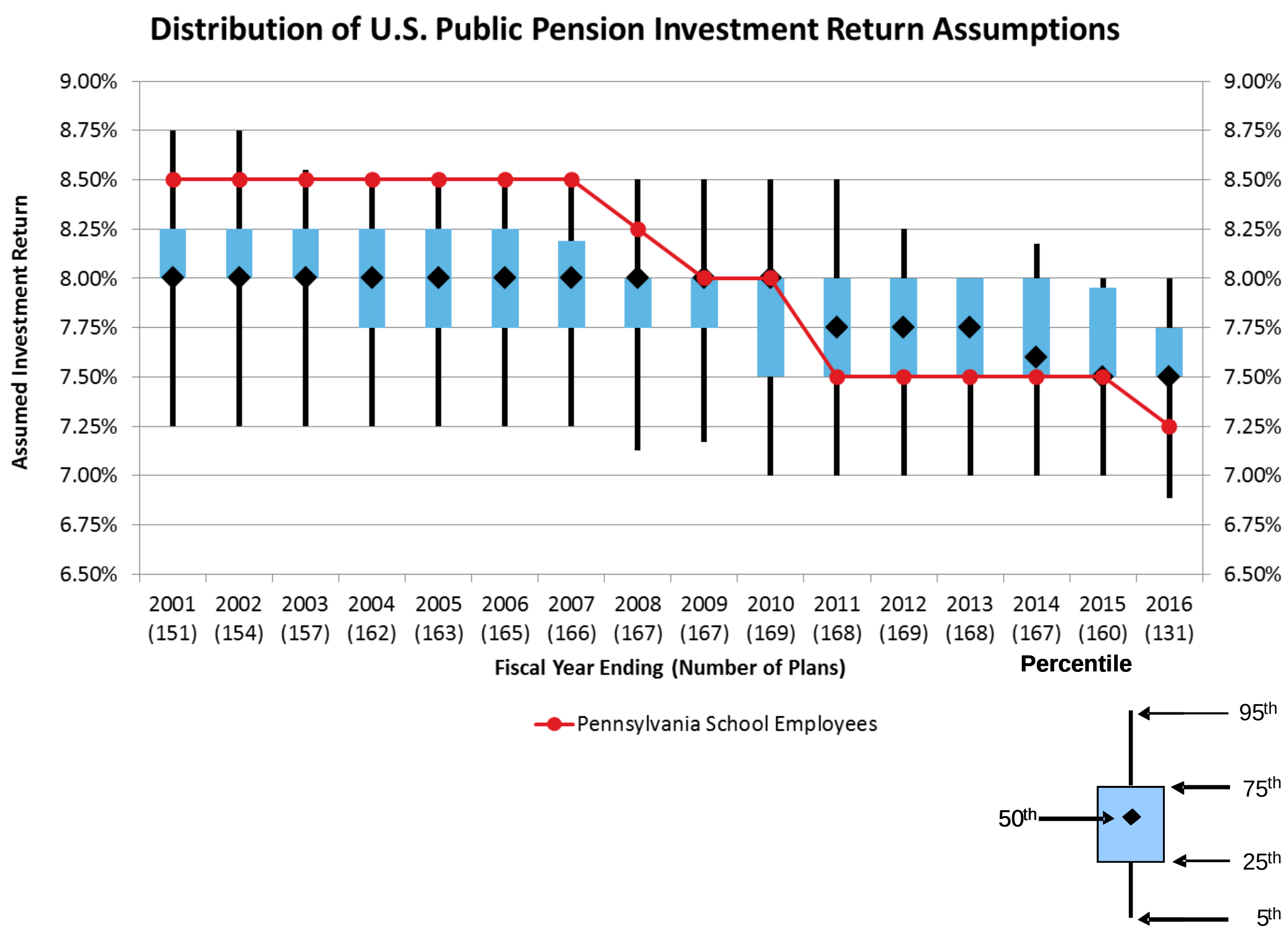
[1]Based on a 7.25% discount rate consistent with the June 30, 2016 valuation results.

[2]Based on plan's valuation interest rate of 7.25%. Using AHIC's 30-year capital market assumptions as of March 31, 2017, the expected return is 7.20%, which also results in a hurdle rate shortfall of $0.8B.

[3]Allocation to Cash includes a 20% leveraged position.

Actuarial Assumption Review

PSERS versus Peers[1]



Key Takeaways:

- Median actuarial assumption for investment return has declined from 8.00% in 2001-2010 to 7.50% based on the latest survey data
- PSERS' assumption for FYE 2016 (7.25%) lied below the median relative to its peers
- If PSERS fails to achieve the actuarial return assumption, higher funding will be needed in future years

Sources: Public Plans Data (publicplansdata.org) as of July 2017; Expected Returns are the assumptions made by the plans included in the data set.

[1] Peers defined as public funds published within publicplansdata.org as of July 2017; Number of plans per year are shown in parentheses

Analysis

- Portfolio Analysis

Portfolio Analysis

How Do We Set Assumptions?

- Our global assumptions are Aon Hewitt's asset class return, volatility and correlation assumptions. "Best estimate" asset class returns, i.e., 50/50 chance actual returns will be below our assumptions.
- Updated quarterly
- Details of our assumptions are shown in the appendices to this material
- Assumptions are set passively except for private equity and hedge funds. We add manager alpha separately for asset classes.
- Time Horizon – Up to 30 years.
- Return assumptions modelled differently according to asset class attributes.
  - E.g., Equities based on discounted dividend ('cash flow') approach:

Dividend Yield (t) → Real Earnings Growth (consensus + fade to long-term real GDP) Payout ratio profile → Dividend yield (t+10) → Valuation Adjustment (at extremes) → Add Inflation

Portfolio Analysis
Capital Market Assumption Overview

- We have what we consider a consistent and conservative approach to modeling asset class returns, risk, and correlations

- AHIC regularly reviews these critical inputs relative to peer consultants as well as the investment management community

Q2 2017 AHIC 10-year Capital Market Assumptions

- Most asset class exposures are represented within the PSERS portfolio

	Real Return	Nominal Return	Risk	Premium Over Cash	Sharpe
US Gov Cash	-0.1%	2.1%	1.0%	0.0%	0.00
LIBOR (Leverage)	0.3%	2.5%	1.1%	0.4%	0.38
US Large Cap	4.2%	6.5%	17.0%	4.4%	0.26
US Small Cap	4.4%	6.7%	23.0%	4.6%	0.20
Intl. Developed Equity[1]	5.6%	7.9%	17.9%	5.8%	0.32
Emerging Mkt. Equity	5.2%	7.5%	30.0%	5.4%	0.18
Private Equity	6.3%	8.6%	24.1%	6.5%	0.27
Core Fixed Income	0.7%	2.9%	4.0%	0.8%	0.19
Long Govt Bonds	0.8%	3.1%	8.7%	0.9%	0.11
High Yield Bonds	1.7%	3.9%	12.0%	1.8%	0.15
Private Debt (2X Levered)	6.7%	9.0%	18.3%	6.9%	0.38
Non-US Developed Bonds[2]	0.2%	2.4%	2.6%	0.2%	0.09
EMD Hard	1.8%	4.1%	13.0%	2.0%	0.15
EMD Local	3.9%	6.1%	14.0%	4.0%	0.29
Global Inflation-Linked[3]	0.4%	2.6%	3.1%	0.5%	0.16
Private Real Estate	3.2%	5.5%	12.5%	3.4%	0.27
REITs	3.9%	6.2%	18.5%	4.1%	0.22
Commodities	2.5%	4.8%	17.0%	2.6%	0.15
Timberland	3.2%	5.5%	15.1%	3.3%	0.22
Private Infrastructure	3.9%	6.2%	14.5%	4.1%	0.28
Public Infrastructure	4.7%	7.0%	17.0%	4.8%	0.29
Gold	0.9%	3.2%	18.9%	1.0%	0.06
Risk Parity[4]	3.6%	5.9%	11.4%	3.7%	0.33
Hedge Funds[5]	2.7%	5.0%	7.6%	2.9%	0.38

1) *Hedged to USD*
2) *Hedged to USD*
3) *40% US, 2% Canada, 31% UK, 27% Europe. Hedged to USD.*
4) *50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate US Govt. Bonds, 20% Commodities*
5) *16% Event Driven, 0% CTA, 38% Global Macro, 0% Distressed Debt, 37% Fixed Income Arbitrage, 9% Cat. Bonds*

Q2 2017 AHIC 30-year Capital Market Assumptions

- Most asset class exposures are represented within the PSERS portfolio

	Real Return	Nominal Return	Risk	Premium Over Cash	Sharpe
US Gov Cash	0.6%	2.8%	1.9%	0.0%	0.00
LIBOR (Leverage)	1.1%	3.3%	2.0%	0.5%	0.25
US Large Cap	4.2%	6.5%	17.2%	3.7%	0.21
US Small Cap	4.7%	7.0%	23.6%	4.2%	0.18
Intl. Developed Equity[1]	4.8%	7.1%	20.4%	4.3%	0.21
Emerging Mkt. Equity	5.2%	7.5%	30.6%	4.8%	0.16
Private Equity	6.3%	8.6%	24.6%	5.8%	0.24
Core Fixed Income	1.5%	3.7%	5.2%	0.9%	0.18
Long Govt Bonds	1.2%	3.4%	11.1%	0.6%	0.05
High Yield Bonds	3.1%	5.4%	12.2%	2.6%	0.21
Private Debt (2X Levered)	6.9%	9.2%	19.3%	6.4%	0.33
Non-US Developed Bonds[2]	0.9%	3.2%	4.1%	0.4%	0.09
EMD Hard	3.0%	5.3%	13.8%	2.5%	0.18
EMD Local	3.9%	6.1%	14.4%	3.4%	0.23
Global Inflation-Linked[3]	0.8%	3.0%	3.4%	0.2%	0.07
Private Real Estate	3.2%	5.5%	12.6%	2.7%	0.21
REITs	3.9%	6.2%	19.1%	3.4%	0.18
Commodities	3.2%	5.5%	17.0%	2.7%	0.16
Timberland	3.2%	5.5%	15.1%	2.7%	0.18
Private Infrastructure	4.0%	6.3%	14.7%	3.5%	0.24
Public Infrastructure	4.8%	7.1%	17.6%	4.3%	0.25
Gold	1.0%	3.2%	19.5%	0.4%	0.02
Risk Parity[4]	3.8%	6.1%	11.9%	3.3%	0.28
Hedge Funds[5]	3.4%	5.6%	8.2%	2.9%	0.35

1) *Hedged to USD*
2) *Hedged to USD*
3) *40% US, 2% Canada, 31% UK, 27% Europe. Hedged to USD.*
4) *50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate US Govt. Bonds, 20% Commodities*
5) *16% Event Driven, 0% CTA, 38% Global Macro, 0% Distressed Debt, 37% Fixed Income Arbitrage, 9% Cat. Bonds*

Portfolio Analysis

AHIC Capital Market Assumption Changes

Below illustrates the changes in AHIC's capital market assumptions over the past 4 years

	10-Year					30-Year				
Asset Allocation	**Q2 2017**	**Q2 2016**	**Q12015**	**Q1 2014**	***Change***	**Q2 2017**	**Q2 2016**	**Q12015**	**Q1 2014**	***Change***
Liquidity										
Cash	2.1%	1.5%	1.8%	2.9%	*-0.8%*	2.8%	2.3%	2.4%	4.2%	*-1.4%*
LIBOR	2.5%	1.7%	2.0%	3.0%	*-0.5%*	3.3%	2.6%	2.7%	4.4%	*-1.1%*
Equity										
Publicly-traded Global Equity[1]	7.4%	7.5%	6.9%	7.3%	*0.1%*	7.4%	7.5%	7.0%	7.5%	*-0.1%*
Private Markets	8.6%	8.8%	8.8%	9.1%	*-0.5%*	8.6%	8.8%	8.8%	9.1%	*-0.5%*
Fixed Income										
Investment Grade	2.9%	2.4%	2.6%	3.6%	*-0.7%*	3.7%	3.3%	3.3%	4.9%	*-1.2%*
Long Treasury Bonds	3.1%	2.7%	3.0%	3.6%	*-0.5%*	3.4%	3.1%	3.2%	4.4%	*-1.0%*
High Yield Bonds	3.9%	6.1%	4.5%	4.5%	*-0.6%*	5.4%	6.5%	4.7%	5.4%	*0.0%*
Non-US Developed Bonds (100% Hedged)	2.4%	1.8%	2.1%	3.2%	*-0.8%*	3.2%	2.7%	2.9%	4.4%	*-1.2%*
Emerging Market Debt (Hard Currency)	4.1%	4.4%	4.8%	5.4%	*-1.3%*	5.3%	5.1%	5.4%	6.4%	*-1.1%*
Inflation-Protected[2]	2.6%	2.5%	2.7%	3.2%	*-0.6%*	3.0%	3.1%	3.2%	4.0%	*-1.0%*
Real Assets										
MLP/Infrastructure[3]	7.0%	6.7%	7.4%	7.8%	*-0.8%*	7.2%	7.0%	7.4%	7.8%	*-0.6%*
Commodities	4.8%	3.8%	4.1%	5.2%	*-0.4%*	5.5%	4.7%	4.8%	6.6%	*-1.1%*
Real Estate	5.5%	6.2%	6.8%	7.2%	*-1.7%*	5.5%	6.2%	6.8%	7.3%	*-1.8%*
Absolute Return [4]	5.0%	5.1%	6.3%	6.9%	*-1.6%*	5.6%	5.5%	6.8%	7.8%	*-2.2%*
Risk Parity [5]	5.9%	5.9%	5.8%	6.4%	*-0.5%*	6.1%	6.1%	6.0%	6.7%	*-0.6%*
PSERS Expected Return (current weights)	**7.0%**	**6.9%**	**6.9%**	**7.5%**	***-0.5%***	**7.2%**	**7.1%**	**7.1%**	**7.9%**	***-0.7%***

[1] 30-year Global Equity is Hedged to reflect recent PSERS policy changes.
[2] Reflects shift to Global TIPs in 2017 per PSERS policy changes
[3] 33.3% Private Infrastructure, 66.7% Public Infrastructure
[4] 16% Event Driven, 0% CTA, 38% Global Macro, 0% Distressed Debt, 37% Fixed Income Arbitrage, 9% Cat. Bonds.
[5] 50% Global Equity, 55% TIPS, 75% Intermediate Gov't Bonds, 20% Commodities, -100% LIBOR.

Portfolio Analysis
Portfolios Evaluated

	1-Year Target Portfolios		Long-Term Portfolios Tested in Asset-Liability Modeling				
	Current Target	Proposed Target	Current Long-Term Target	Clean Slate	Less Illiquids	60/40	Low Risk
Cash	3.0%	3.0%	3.0%	0.0%	3.0%	0.0%	3.0%
LIBOR (Leverage)	-17.0%	-17.0%	-20.0%	-25.0%	-17.0%	0.0%	0.0%
Total Cash	**-14.0%**	**-14.0%**	**-17.0%**	**-25.0%**	**-14.0%**	**0.0%**	**3.0%**
US Large Cap	6.3%	6.3%	6.6%	10.1%	9.3%	19.9%	4.6%
US Small Cap	1.1%	1.1%	1.2%	1.8%	1.6%	3.5%	0.9%
Intl. Developed Equity[1]	8.6%	8.6%	9.4%	14.2%	13.2%	28.2%	6.6%
Emerging Mkt. Equity	3.0%	3.0%	2.8%	4.3%	3.9%	8.4%	1.9%
Private Equity	16.0%	15.0%	15.0%	8.9%	11.0%	0.0%	11.0%
Total Equities	**35.0%**	**34.0%**	**35.0%**	**39.3%**	**39.0%**	**60.0%**	**25.0%**
Core Fixed Income	5.0%	5.0%	5.0%	11.9%	5.0%	40.0%	5.0%
Long Govt Bonds	3.0%	3.0%	5.0%	23.8%	5.0%	0.0%	6.0%
High Yield Bonds	1.6%	0.0%	1.6%	1.3%	1.6%	0.0%	1.2%
Private Debt (2X Levered)	6.4%	10.0%	6.4%	5.5%	6.4%	0.0%	4.8%
Non-US Developed Bonds[2]	1.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%
EMD Hard	0.5%	0.0%	1.0%	3.3%	1.0%	0.0%	0.5%
EMD Local	0.5%	1.0%	1.0%	3.3%	1.0%	0.0%	0.5%
Global Inflation-Linked[3]	15.0%	15.0%	15.0%	0.0%	13.0%	0.0%	20.0%
Total Fixed Income	**33.0%**	**35.0%**	**36.0%**	**49.1%**	**34.0%**	**40.0%**	**39.0%**
Private Real Estate	11.0%	10.0%	8.0%	8.6%	9.0%	0.0%	6.0%
REITs	1.0%	1.0%	2.0%	1.9%	3.0%	0.0%	1.0%
Commodities	5.0%	5.0%	5.0%	1.4%	5.0%	0.0%	3.8%
Timberland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Private Infrastructure	2.0%	1.0%	4.0%	1.5%	0.0%	0.0%	2.0%
Public Infrastructure	4.0%	5.0%	4.0%	0.0%	3.0%	0.0%	4.0%
Gold	3.0%	3.0%	3.0%	0.0%	3.0%	0.0%	2.3%
Total Real Assets	**26.0%**	**25.0%**	**26.0%**	**13.4%**	**23.0%**	**0.0%**	**19.0%**
Risk Parity[4]	**10.0%**	**10.0%**	**10.0%**	**5.8%**	**10.0%**	**0.0%**	**7.0%**
Hedge Funds[5]	**10.0%**	**10.0%**	**10.0%**	**17.4%**	**8.0%**	**0.0%**	**7.0%**
Total Plan	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
30-Year Expected Nominal Return	**7.15%**	**7.29%**	**7.20%**	**7.18%**	**7.13%**	**6.32%**	**6.21%**
30-Year Expected Real Return	**4.88%**	**5.01%**	**4.93%**	**4.90%**	**4.85%**	**4.05%**	**3.95%**
30-Year Expected Risk	**10.85%**	**10.91%**	**10.90%**	**10.88%**	**11.22%**	**11.44%**	**7.97%**
Sharpe Ratio	**0.402**	**0.411**	**0.404**	**0.403**	**0.386**	**0.308**	**0.427**
% Illiquids	**45.4%**	**46.0%**	**43.4%**	**41.9%**	**34.4%**	**0.0%**	**30.8%**

[1] Hedged to USD

[2] Hedged to USD

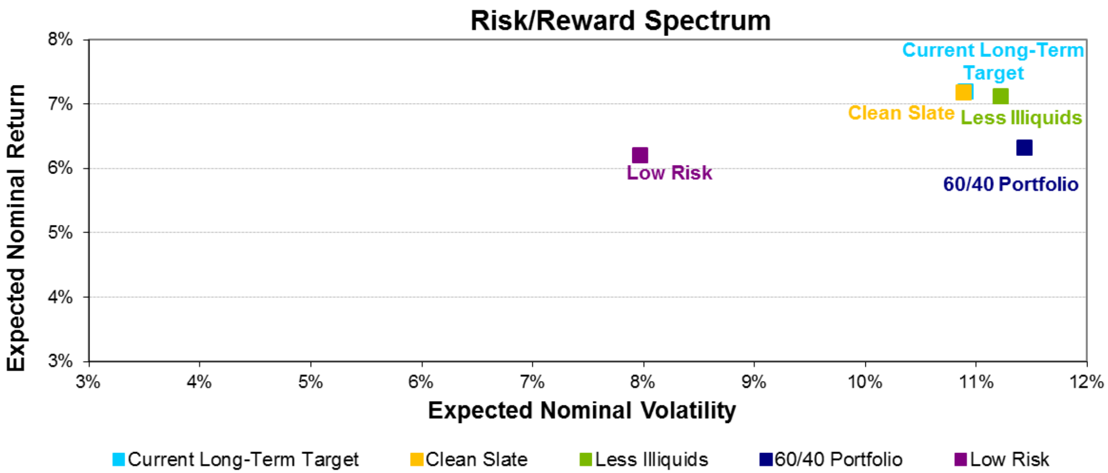
[3] 40% US, 2% Canada, 31% UK, 27% Europe. Hedged to USD.

[4] 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate US Govt. Bonds, 20% Commodities

[5] 16% Event Driven, 0% CTA, 38% Global Macro, 0% Distressed Debt, 37% Fixed Income Arbitrage, 9% Cat. Bonds

Portfolio Analysis

30-Year Capital Market Assumptions



Key Takeaways:

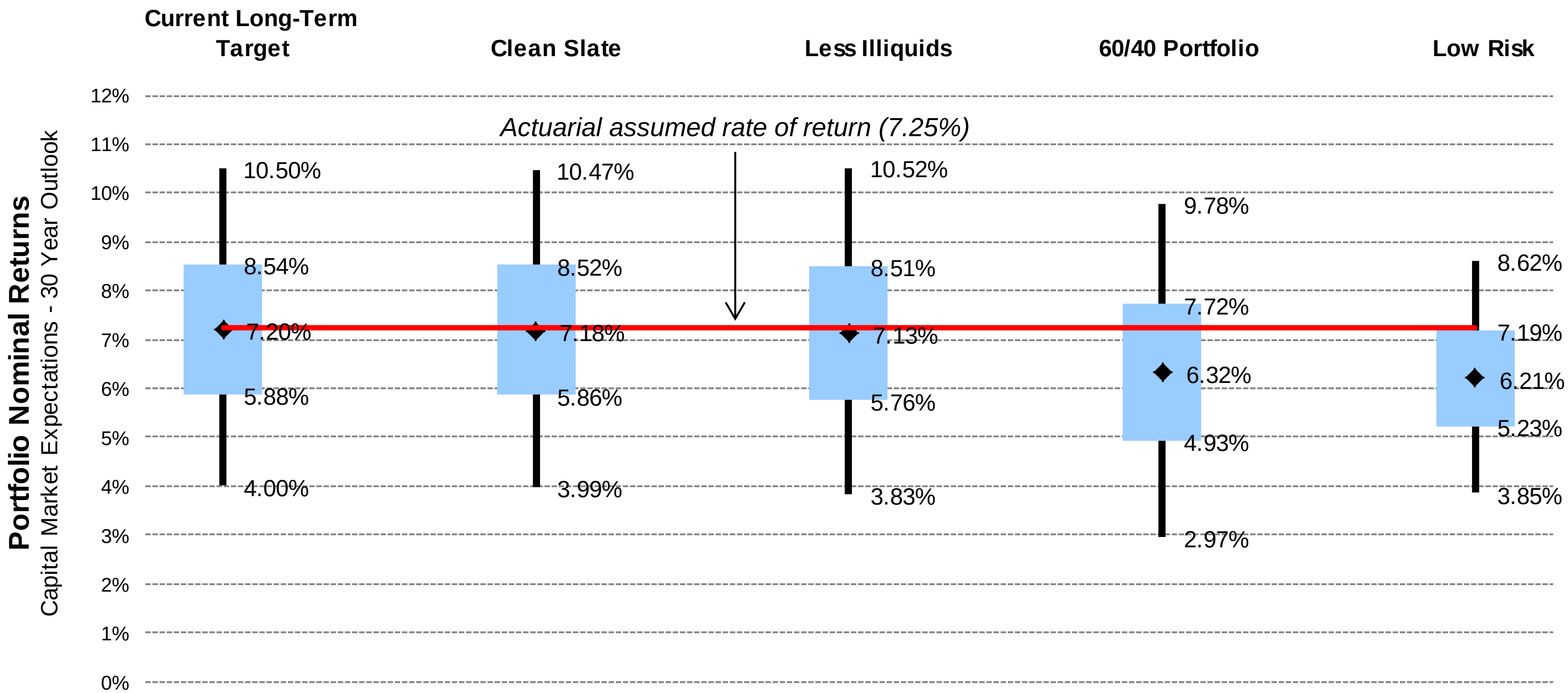
- The Current Long-Term Target portfolio has a high allocation to return-seeking assets
  - Return-seeking assets are broadly diversified
- The Current Long-Term Target portfolio includes a leveraged position of 20%

Portfolio Weights

				Equity Returns	Diversified Returns				Skill				Safety					
	Exp. Nom. Return	Exp. Nom. Vol.	Sharpe Ratio	Global Equity	High Yield Bonds / Private Debt	Emerg. Market Debt	Real Estate	Comm-odities	Hedge Funds	Risk Parity	Private Equity	Infra-struc-ture	Global TIPS	Cash	Core Bonds	Long Dur. Gov't Bonds	Dev. Int'l Debt	Lever-aged
Current Long-Term Target	7.20%	10.90%	0.404	20%	8%	2%	10%	8%	10%	10%	15%	8%	15%	3%	5%	5%	1%	-20%
Clean Slate	7.18%	10.88%	0.403	30%	7%	7%	11%	1%	17%	6%	9%	2%	0%	0%	12%	24%	0%	-25%
Less Illiquids	7.13%	11.22%	0.386	28%	8%	2%	12%	8%	8%	10%	11%	3%	13%	3%	5%	5%	1%	-17%
60/40 Portfolio	6.32%	11.44%	0.308	60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%	0%	0%
Low Risk	6.21%	7.97%	0.427	14%	6%	1%	7%	6%	7%	7%	11%	6%	20%	3%	5%	6%	1%	0%

Portfolio Analysis

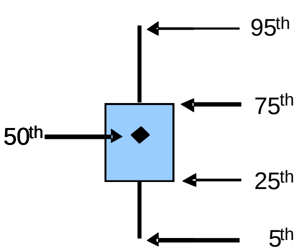
Range of Nominal Returns – 30-Year Capital Market Assumptions



Key Takeaway:

- The Current Long-Term Target (7.20%) and Clean Slate portfolios (7.18%) are projected to be slightly lower than the actuarial assumed rate of return (7.25%) in the 50th percent outcome

Percentile



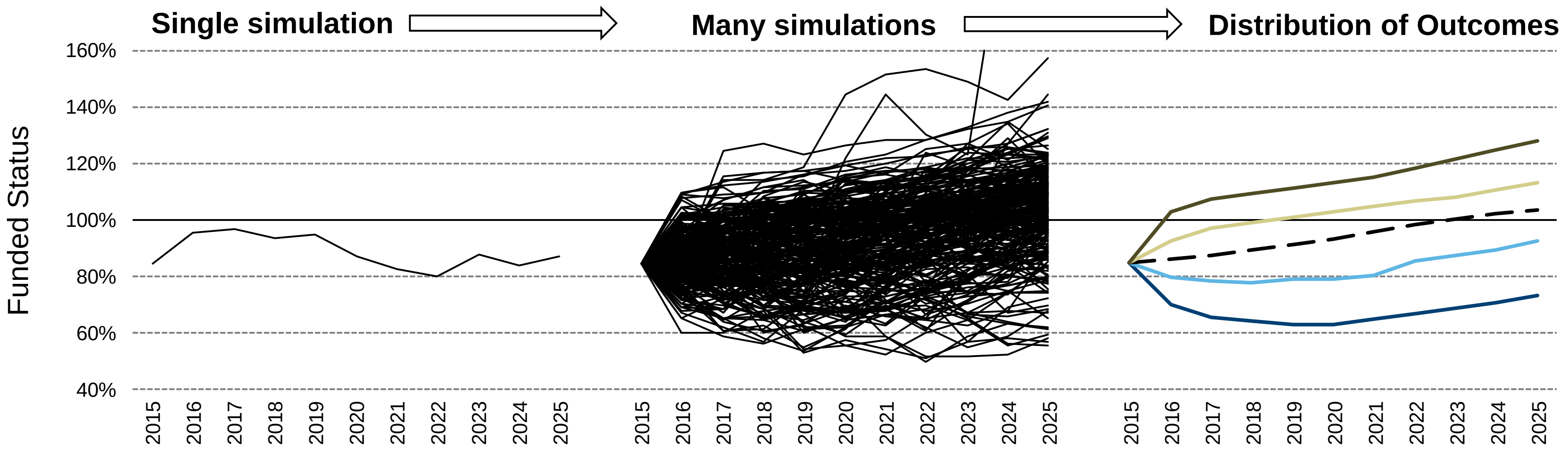
Note: Returns based on AHIC's 30-Year Capital Market Assumptions as of March 31, 2017

Analysis

- Asset-Liability Projection Results (Stochastic)

Asset-Liability Simulation Overview

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



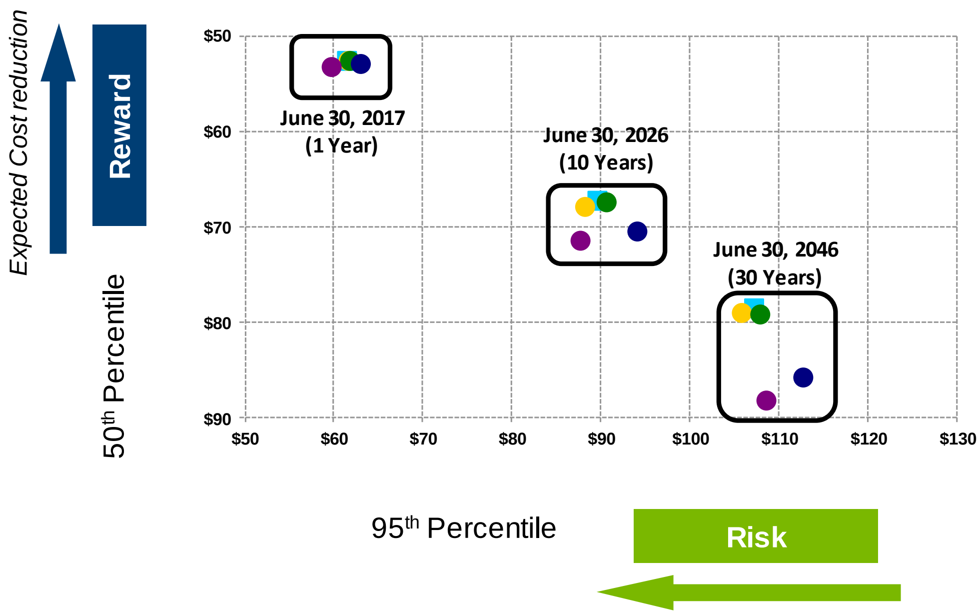
* The path of a given scenario will follow a much less smooth pattern than the distribution suggests, as illustrated above

Asset-Liability Projection Results (Stochastic Results)

Economic Cost Analysis—1-Year, 10-Year, and 30-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 7.25%, $billions



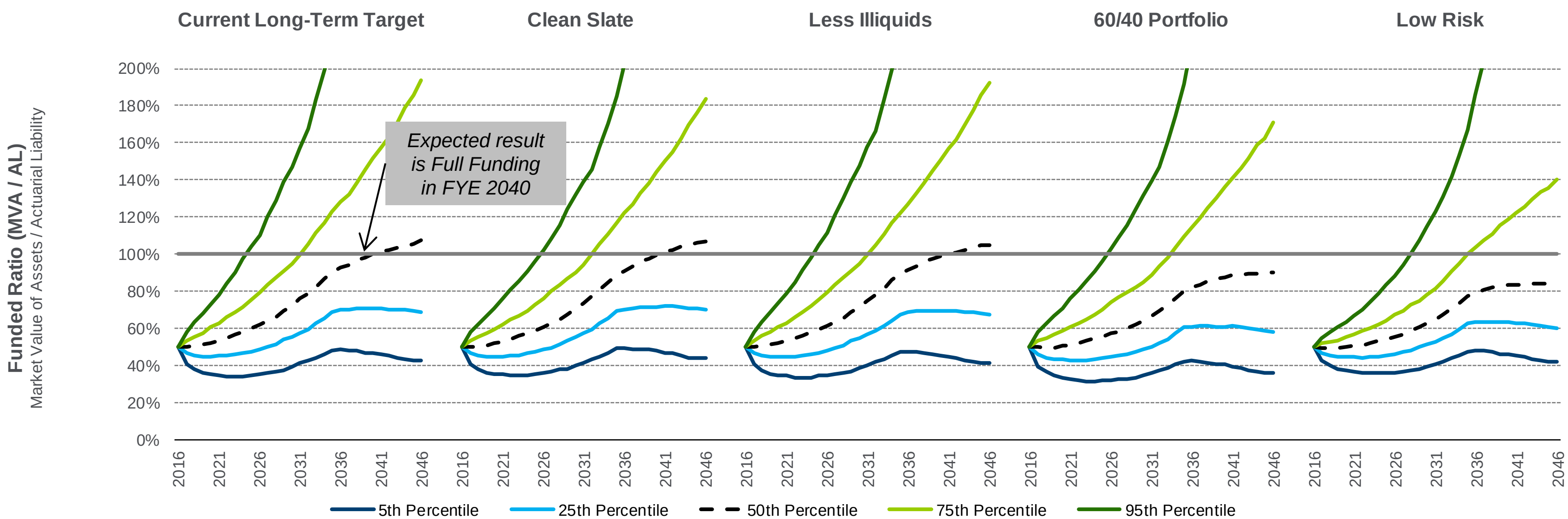
Strategy ($Billions)	Cost	Risk
Economic Cost June 30, 2017		
Current Long-Term Target	$52.6	$61.5
Clean Slate	$52.7	$61.6
Less Illiquids	$52.6	$61.8
60/40 Portfolio	$52.9	$62.9
Low Risk	$53.3	$59.7
June 30, 2026		
Current Long-Term Target	$67.2	$89.5
Clean Slate	$68.0	$88.2
Less Illiquids	$67.4	$90.6
60/40 Portfolio	$70.5	$94.1
Low Risk	$71.4	$87.8
June 30, 2046		
Current Long-Term Target	$78.6	$107.3
Clean Slate	$79.1	$105.8
Less Illiquids	$79.2	$108.0
60/40 Portfolio	$85.8	$112.8
Low Risk	$88.2	$108.6

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Under the Long-Term Target allocation over a 30-year time horizon, the expected Economic Cost is $78.6B and the potential risk is $107.3B
- Adjustments to the return-seeking allocation may have desirable risk/reward characteristics relative to the Long-Term Target policy

* Liability projections assume discount rates of 7.25% for all investment policies studied; Reflects a *utility function:* Excludes 50% of surplus in excess of 120% of Actuarial liability, and includes twice the shortfall below 40% of Actuarial liability, on a market value basis

Asset-Liability Projection Results (Stochastic Results)
Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	Current Long-Term Target			Clean Slate			Less Illiquids			60/40 Portfolio			Low Risk		
Year	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**
5th Percentile	35%	49%	43%	36%	50%	44%	35%	48%	41%	32%	42%	36%	36%	48%	42%
25th Percentile	49%	70%	69%	48%	70%	70%	48%	68%	68%	44%	61%	58%	46%	63%	60%
50th Percentile	62%	93%	107%	61%	91%	107%	62%	92%	105%	57%	82%	90%	56%	79%	84%
75th Percentile	79%	128%	193%	76%	122%	183%	79%	127%	192%	74%	114%	171%	67%	104%	140%
95th Percentile	110%	238%	672%	102%	202%	510%	111%	243%	679%	103%	213%	630%	88%	186%	478%
Probability > 100%	12%	45%	55%	7%	43%	55%	12%	44%	53%	7%	36%	47%	<5%	29%	43%

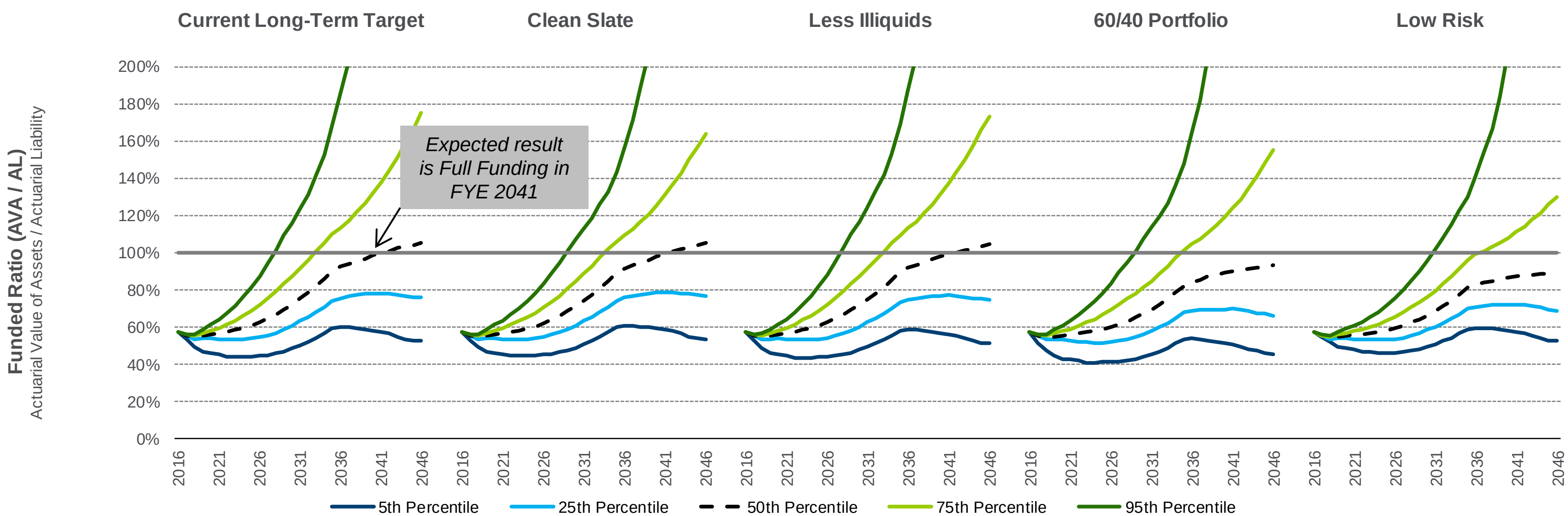
Key Takeaways:

- The funded ratio is projected to trend toward full funding over the course of the projection period
- Adverse market experience could significantly impact the funded status of the Plan

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results)

Actuarial Value of Assets / Actuarial Liability Funded Ratio



Strategy	Current Long-Term Target			Clean Slate			Less Illiquids			60/40 Portfolio			Low Risk		
Year	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**	**2026**	**2036**	**2046**
5th Percentile	44%	60%	53%	45%	61%	53%	44%	59%	51%	41%	54%	46%	46%	59%	53%
25th Percentile	54%	75%	76%	55%	76%	77%	54%	75%	74%	52%	68%	66%	54%	71%	69%
50th Percentile	63%	92%	105%	62%	91%	105%	62%	92%	104%	60%	84%	93%	59%	83%	88%
75th Percentile	72%	113%	175%	70%	109%	163%	72%	113%	173%	69%	105%	155%	65%	99%	130%
95th Percentile	87%	186%	542%	83%	156%	407%	88%	187%	548%	83%	164%	502%	75%	140%	378%
Probability > 100%	<5%	41%	54%	<5%	38%	54%	<5%	40%	54%	<5%	30%	47%	<5%	24%	43%

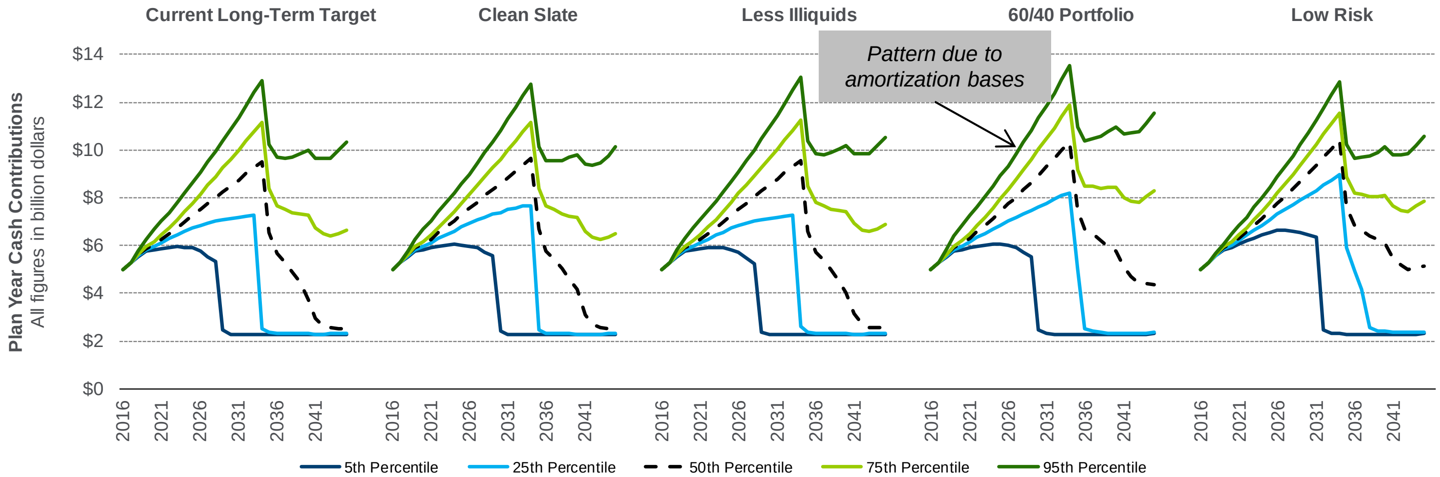
Key Takeaway:

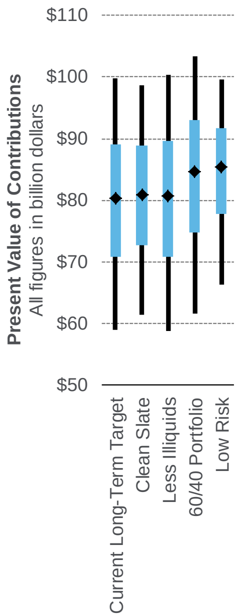
- Actuarial values of assets contain smoothing parameters resulting in narrower dispersions of results

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results)

Gross Contribution Amount (Includes Employee and Employer Contributions)

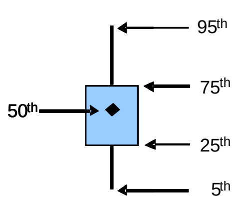




Strategy	Current Long-Term Target			Clean Slate			Less Illiquids			60/40 Portfolio			Low Risk		
Year	2024	2034	2044	2024	2034	2044	2024	2034	2044	2024	2034	2044	2024	2034	2044
5th Percentile	$5.9	$2.3	$2.3	$6.0	$2.3	$2.3	$5.9	$2.3	$2.3	$6.0	$2.3	$2.3	$6.4	$2.3	$2.3
25th Percentile	$6.6	$2.5	$2.3	$6.6	$7.6	$2.3	$6.6	$2.6	$2.3	$6.7	$8.2	$2.3	$6.9	$9.0	$2.4
50th Percentile	$7.0	$9.5	$2.5	$7.0	$9.7	$2.5	$7.0	$9.6	$2.5	$7.1	$10.3	$4.4	$7.1	$10.4	$5.1
75th Percentile	$7.4	$11.2	$6.5	$7.4	$11.2	$6.3	$7.4	$11.3	$6.7	$7.6	$11.9	$8.0	$7.4	$11.6	$7.6
95th Percentile	$8.2	$12.9	$10.0	$8.2	$12.8	$9.7	$8.3	$13.0	$10.2	$8.5	$13.5	$11.1	$8.0	$12.8	$10.2
Probability > $7B	49%	59%	22%	51%	77%	21%	49%	59%	23%	57%	79%	32%	62%	81%	31%

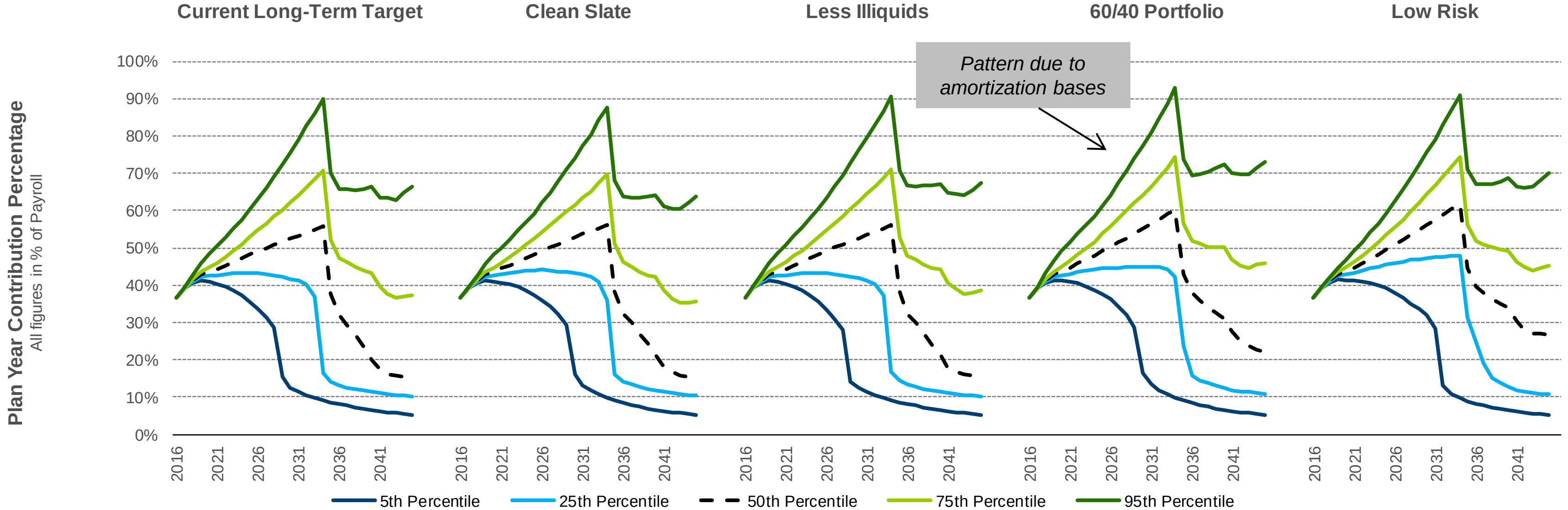
Key Takeaway:

- Contributions in the central expectation (50th percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis



* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results)
Gross Contribution Percentage of Payroll (Includes Employee and Employer Contributions)



Strategy	Current Long-Term Target			Clean Slate			Less Illiquids			60/40 Portfolio			Low Risk		
Year	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**
5th Percentile	37%	9%	5%	39%	10%	5%	37%	9%	5%	39%	10%	5%	40%	10%	5%
25th Percentile	43%	16%	10%	44%	36%	11%	43%	17%	10%	44%	42%	11%	45%	48%	11%
50th Percentile	47%	56%	15%	47%	56%	16%	47%	56%	16%	48%	60%	23%	48%	62%	27%
75th Percentile	51%	71%	37%	51%	70%	35%	51%	71%	38%	52%	74%	46%	51%	74%	45%
95th Percentile	58%	90%	65%	57%	88%	62%	58%	91%	66%	59%	93%	71%	57%	91%	68%
Probability > 50%	31%	54%	16%	30%	58%	14%	31%	54%	16%	36%	64%	22%	36%	71%	20%

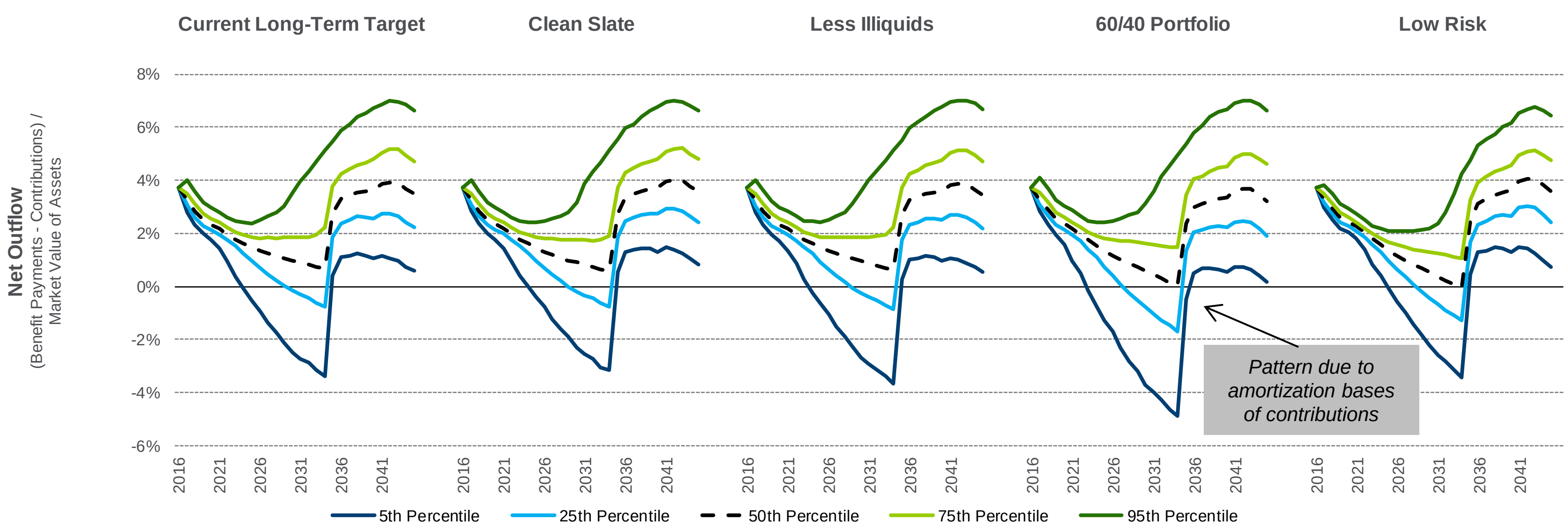
Key Takeaway:

- The trajectories of the central expectations (50th percentile outcomes) are projected to increase until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results)

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



Strategy	Current Long-Term Target			Clean Slate			Less Illiquids			60/40 Portfolio			Low Risk		
Year	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**	**2024**	**2034**	**2044**
5th Percentile	0%	-3%	1%	0%	-3%	1%	0%	-4%	1%	-1%	-5%	0%	0%	-3%	1%
25th Percentile	1%	-1%	2%	1%	-1%	3%	1%	-1%	2%	1%	-2%	2%	1%	-1%	3%
50th Percentile	2%	1%	4%	2%	1%	4%	2%	1%	4%	2%	0%	3%	2%	0%	4%
75th Percentile	2%	2%	5%	2%	2%	5%	2%	2%	5%	2%	1%	5%	2%	1%	5%
95th Percentile	2%	5%	7%	2%	5%	7%	2%	5%	7%	2%	5%	7%	2%	4%	7%
Probability > 3%	<5%	20%	64%	<5%	18%	67%	<5%	20%	63%	<5%	16%	59%	<5%	13%	68%

Key Takeaway:

- Net outflow is consistent across the policies modeled, sharply increasing once amortization bases falls out of the contribution calculations

* Liability projections assume discount rates of 7.25% for all investment policies studied

Deterministic Liquidity Analysis

Liquidity Analysis
Overview

- PSERS' liquidity analysis is performed under its **Current Long-Term Target** portfolio
  – 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 four buckets
  – **Liquid:** less than 3 months needed for return of capital (e.g. publicly traded securities)
  – **Quasi-Liquid:** Typical lock-up of 3–12 months. Conservatively, we assumed a 1-year lock-up in most economic environments, 2 years in a Recession scenario, and 3 years in a Black Skies scenario (e.g. many hedge funds, core real estate)
  – **Illiquid: Potential lock-up of 5–10 years**, depending on economic environment (e.g. closed-ended real estate)
  – **Illiquid: Potential lock-up of 10+ years** (e.g. typical private equity)

- This is intended to be a <u>conservative</u> approximation of the actual liquidity properties of the assets

- Not surprisingly, varying economic scenarios would lead PSERS' percentage allocation to alternative assets to differ from its targets due to liquidity differences in asset classes

Liquidity Analysis

Asset Allocation and Liquidity Category (Current Long-Term Target portfolio)

Asset Class	Target Allocations				
	Total portfolio	Liquid	Quasi-Liquid	Illiquid: 5-10 Years	Illiquid: 10+ Years
Cash	3.0%	3.0%			
LIBOR – Financing	-20.0%	-20.0%			
Public Equities	20.0%	20.0%			
Private Equity	15.0%				15.0%
Core Fixed Income	5.0%	5.0%			
Long Treasuries	5.0%	5.0%			
Global Inflation Linked	15.0%	15.0%			
Non-US Fixed Income	1.0%	1.0%			
Emerging Market Debt	2.0%	2.0%			
High Yield Bonds / Private Debt[1]	8.0%			8.0%	
REITs	2.0%	2.0%			
Broad Real Estate[2]	8.0%			8.0%	
Commodities	5.0%	5.0%			
Gold	3.0%	3.0%			
Infrastructure (Public / Private)[3]	8.0%		4.0%		4.0%
Hedge Funds	10.0%		10.0%		
Risk Parity	10.0%	10.0%			
Total	**100.0%**	**51.0%**	**14.0%**	**16.0%**	**19.0%**

[1] In Distressed debt with limited liquidity from closed end funds
[2] Closed end Real Estate Fund
[3] 50% Public (MLPs) / 50% Private

Liquidity Analysis
Economic Scenarios

- **Base Scenario**
  - Markets perform as expected (~50th percentile)

- **Blue Skies Scenario**
  - Optimistic outlook for markets (~10th percentile)
  - Return-seeking assets increase materially

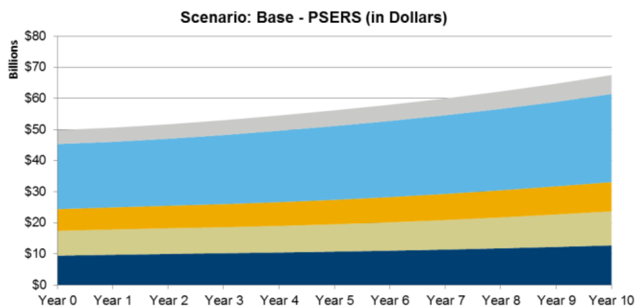
- **Recession Scenario**
  - Somewhat pessimistic outlook for the markets (~95th percentile)
  - Return-seeking assets decline in the first two years with a modest rebound in later years.

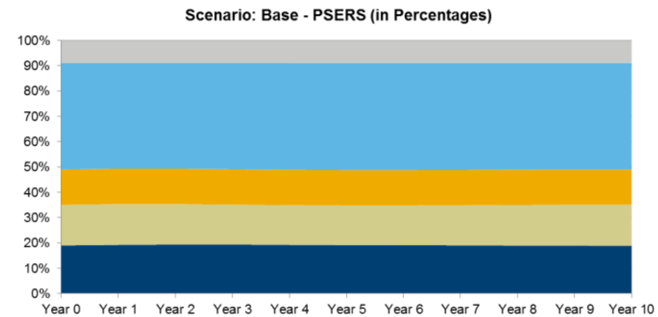
- **Black Skies Scenario**
  - Very pessimistic outlook for markets (~99th percentile)
  - Return-seeking assets decline significantly. The value of public equities roughly splits in half over three years, without an immediate rebound

Liquidity Analysis
Results

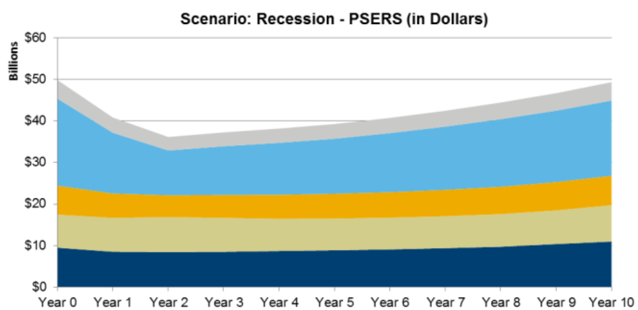
■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid ■ Risk-Reducing Assets

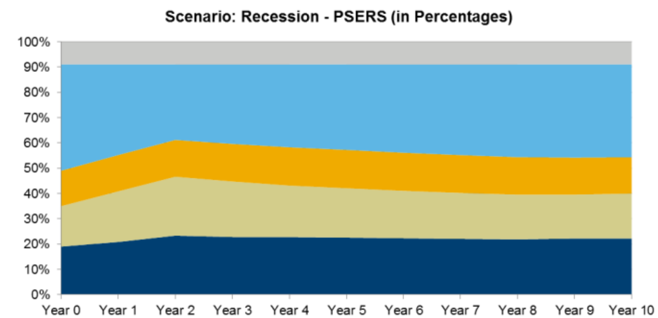
Base Case



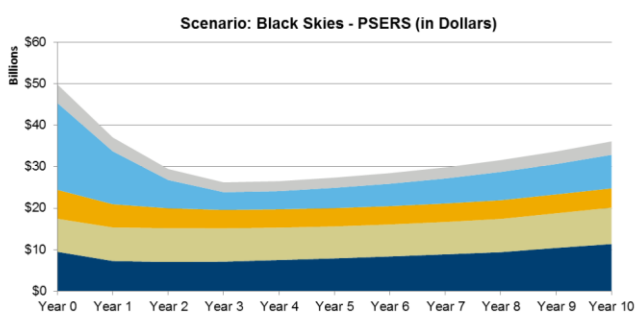


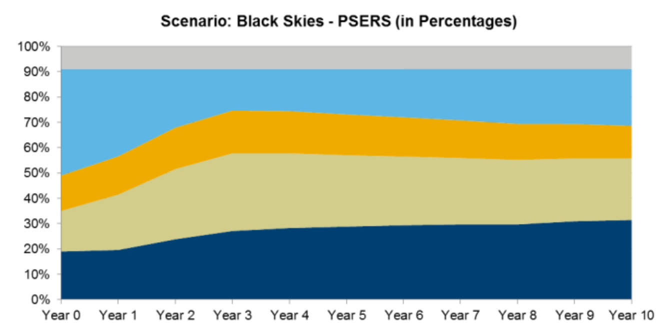
Recession





Black Skies





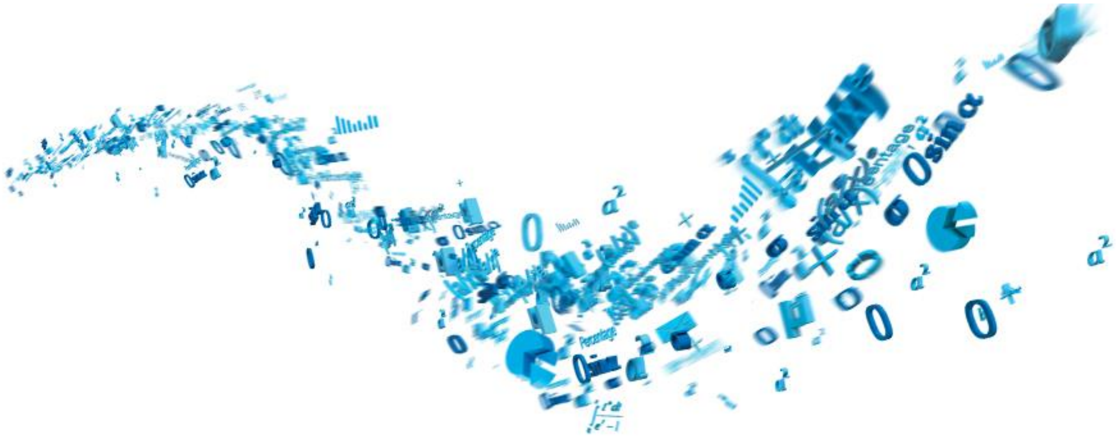
Liquidity Analysis
Conclusions

- **Base Scenario**
  – The total illiquid and quasi-liquid assets can be maintained near the target with no cash flow problems

- **Recession Scenario**
  – We do not foresee potential cash flow issues occurring in the Recession scenario, but the allocation could drift enough from the targets that PSERS may want to rebalance

- **Black Skies Scenario**
  – The asset allocation could drift far from the target allocation.
    - Redemption of Quasi-Liquid assets would not be sufficient to approach the target allocation to illiquid assets
    - Under this scenario, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest.

- This analysis is highly sensitive to the assumed contributions
  – Gross contributions (Employer + Employee portions) are projected to reach $8.97B under the Recession scenario after 10 years and $10.01B under the Black Skies scenario
  – If PSERS receives less contributions than assumed, especially in a Black Skies environment, then the potential liquidity issue would be worse than projected here.



Summary and Conclusions

Summary and Conclusions
Portfolio Analysis

- **Proposed 1-Year Target**
  - Improves the return versus the Current 1-Year Target by 14bps
  - Better risk adjusted returns based on the Sharpe Ratio
- **Asset Allocation**
  - Higher leverage allows for higher allocation to risk-reducing assets without having to reduce return-seeking assets, providing more balanced sources of risk
  - Increasing return-seeking fixed income diversifies equity risk by reducing the need for public equities
- **Modeled Portfolios**
  - **Long-Term Target:** Unchanged from Current Long-Term Target
    - Improves expected return and risk-adjusted return versus the 2016 study due to higher expected returns
    - Provides the lowest expected economic cost during the 30-year time horizon of all the portfolios tested at $78.6 billion
  - **Clean Slate:** 25% leverage versus Current Long-Term Target of 20% Leverage
    - Return/Risk profile very similar to the Current Long-Term Target
    - Stochastic Liability modelling suggests similar expectations for economic cost, future contributions and funded ratio versus the Current Long-Term Target
  - **Less Illiquids:** A lower cost portfolio representing a lower allocation to Illiquid asset classes (9% lower) versus the Long-Term Target
    - Expected return is lower (0.07%) with higher volatility (0.32%) versus the Long-Term Target
    - Not as attractive as the Long-Term Target given the higher expected returns, higher economic cost and lower expected funded ratio in both the expected and downside scenarios

Summary and Conclusions
Portfolio Analysis (continued)

- **60/40 Portfolio:** A low cost portfolio representing passive investments in 60% Global Equity / 40% Core Fixed Income portfolio
  - Expected nominal return and volatility fall far short of Current Long-Term Target (0.88% lower return with 0.54% higher expected volatility)
  - Less diverse portfolio leads to easier management
  - Not attractive given the higher expected contributions and lower expected funded ratios
- **Low Risk Portfolio:** An optimized portfolio, using the existing asset classes without leverage, seeking a 5.90% return
  - Improves volatility compared to Long-Term Target but also significantly decreases expected return to 5.90%
  - Not attractive given the higher expected contributions and lower expected funded ratios
  - Given PSERS' current underfunding, the portfolio return generated is not attractive, but this portfolio could be attractive should PSERS' funded ratio improve

▪ **Liquidity Analysis**:
- The total illiquid and quasi-liquid assets can be maintained near the target with no cash flow problems in the Base scenario
- We do not foresee potential cash flow issues occurring in the Recession scenario, but the allocation could drift enough from the targets that PSERS may want to rebalance
- Under a Black Skies scenario, the asset allocation could drift far from the target allocation. Redemption of Quasi-Liquid assets would not be sufficient to approach the target allocation to illiquid assets. Under this scenario, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest.
- This analysis is highly sensitive to the assumed contributions. If PSERS receives less contributions than the full actuarially assumed amount, especially in a Black Skies environment, then the potential liquidity risk would be higher.

Summary and Conclusions

Asset-Liability Projection Results (Stochastic Results)

All Scenarios	30-Year Economic Cost		30-Year Present Value of Contributions		30-Year Ending Funded Ratio (MVA / AL)	
$ Billions	**Expected[1]**	**Downside[2]**	**Expected[1]**	**Downside[2]**	**Expected[1]**	**Downside[3]**
Current Long-Term Target	$78.6	$107.3	$80.4	$99.8	107%	43%
Clean Slate	$79.1	$105.8	$80.9	$98.6	107%	44%
Less Illiquids	$79.2	$108.0	$80.7	$100.4	105%	41%
60/40 Portfolio	$85.8	$112.8	$84.6	$103.4	90%	36%
Low Risk	$88.2	$108.6	$85.3	$99.5	84%	42%

Key Findings:

- The Plan is expected to reach full funding in the central expectation (50th percentile) over the course of the projection period assuming the expected contributions are made
- Adverse market experience could significantly impact the funded status of the Plan

[1] Expected = 50th percentile outcome or central expectation across all 5,000 simulations
[2] Downside = 95th percentile outcome across all 5,000 simulations
[3] Downside = 5th percentile outcome across all 5,000 simulations

Recommendations

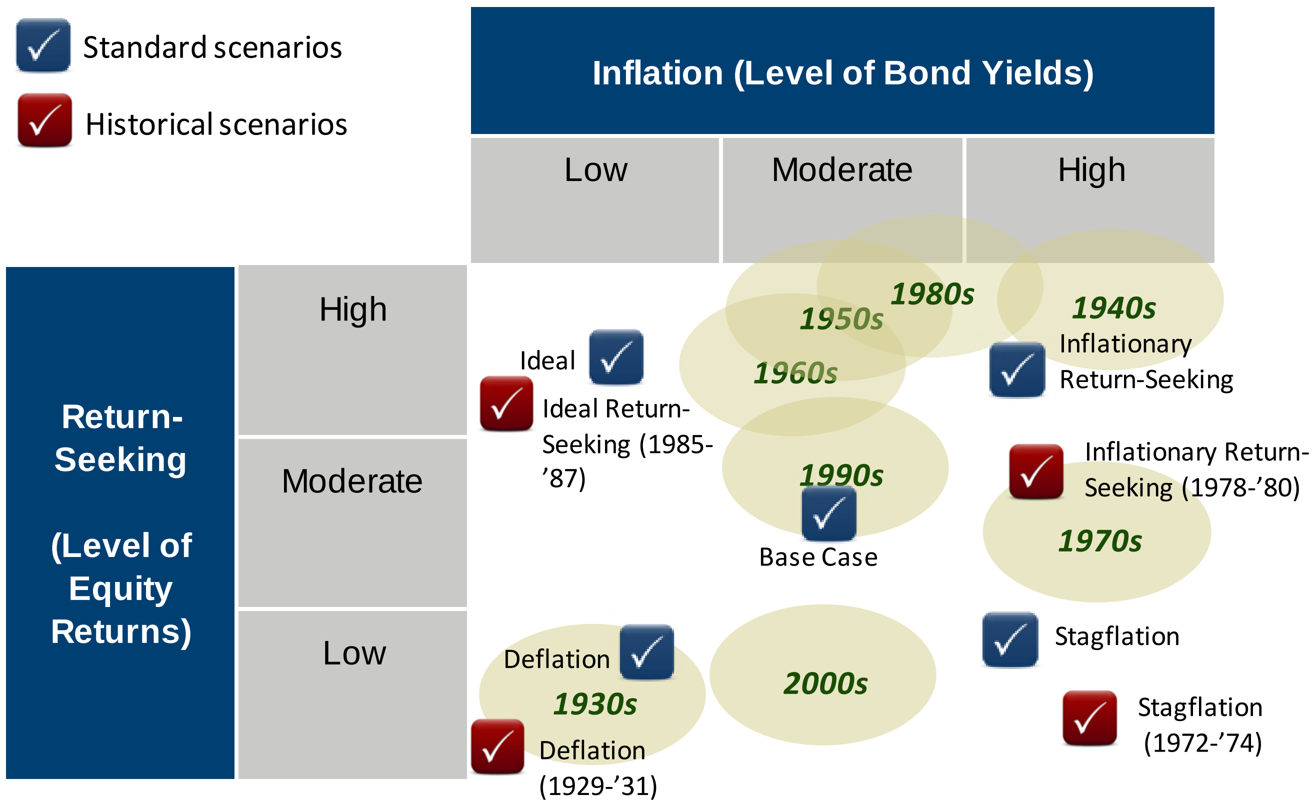
- AHIC recommends PSERS adopt the Proposed 1-Year Target portfolio
  - The portfolio provides better risk-adjusted returns as measured by the Sharpe Ratio (0.411 versus 0.402)
  - The expected return of the portfolio improves by 14bps to 7.29% with only a slight increase in volatility

- AHIC recommends PSERS maintain the Current Long-Term Target as its Long-Term Policy Target Portfolio
  - Provides the lowest expected economic cost during the 30-year time horizon of all the portfolios tested at $78.6 billion
  - The Long-Term Target portfolio has a 55% chance of attaining a fully funded status over the 30 year projection period
  - Strong risk-adjusted returns based on the Sharpe Ratio

Appendix

- Additional Scenario Analysis (Subsets of the Stochastic Projections)

Asset-Liability Projection Results (Stochastic Results)
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 above provides historical context for the five scenarios

Asset-Liability Projection Results (Stochastic Results)

Scenario Analysis

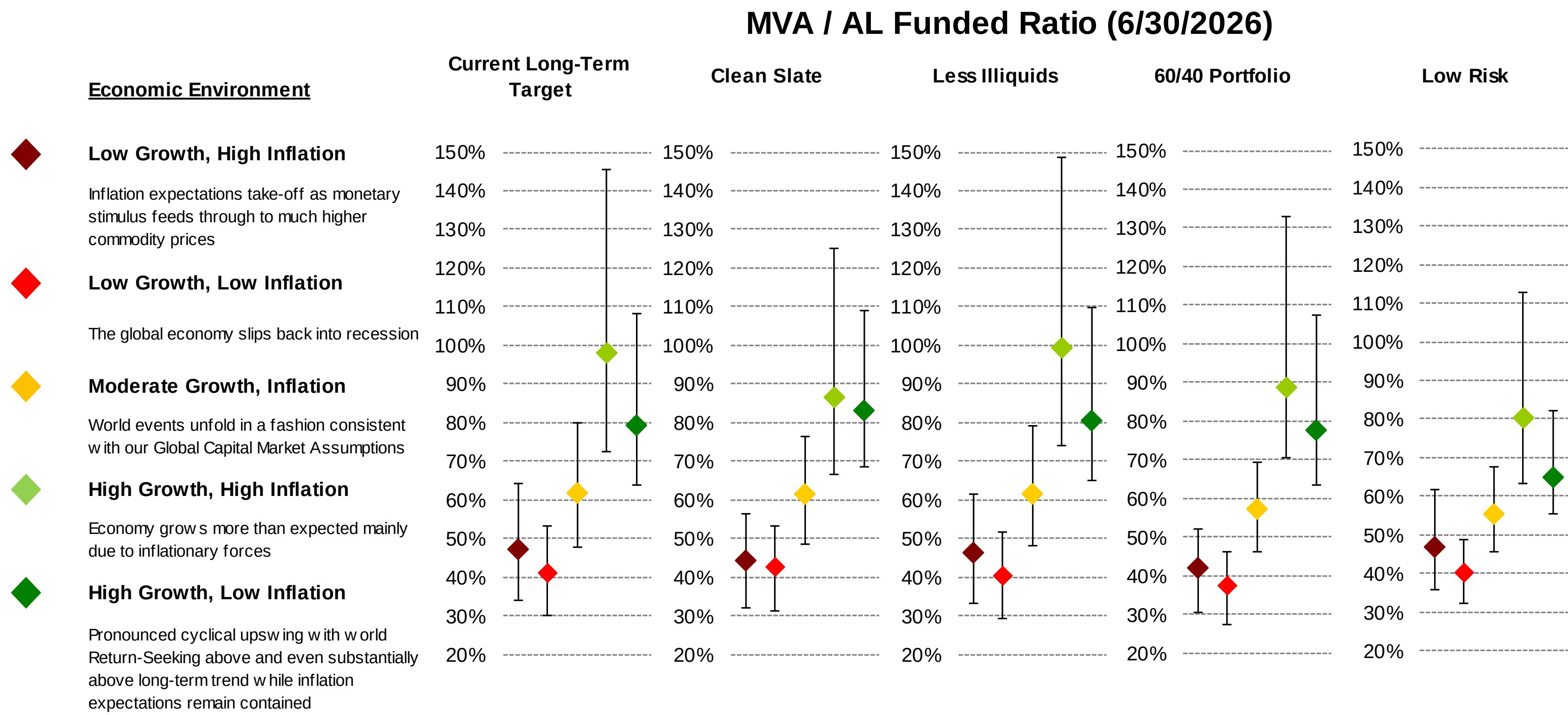
✓ Standard scenarios

Return-Seeking (Level of Equity Returns)		Inflation (Level of Bond Yields): Low Avg yield = 1.3%	Inflation (Level of Bond Yields): Moderate Avg yield = 2.8%	Inflation (Level of Bond Yields): High Avg yield = 5.2%
	High Avg return = 16.3%	✓ **6% weight**	**11% weight**	✓ **13% weight**
	Moderate Avg return = 8.8%	**12% weight**	✓ **17% weight**	**11% weight**
	Low Avg return = 1.5%	✓ **12% weight**	**12% weight**	✓ **6% weight**

- 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”.

Asset-Liability Projection Results (Stochastic Results)

"What if?" Scenario Analysis | Market Value of Assets / Actuarial Liability Funded Ratio



Key Takeaways:

- Higher allocations to return-seeking assets will improve the expected funded ratios in favorable economic conditions
- Lower risk strategies can help insulate the downside expectations but without the potential upside

Asset-Liability Projection Results (Stochastic Results)

"What if?" Scenario Analysis | Gross Contribution (Includes Employee and Employer Contributions)

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

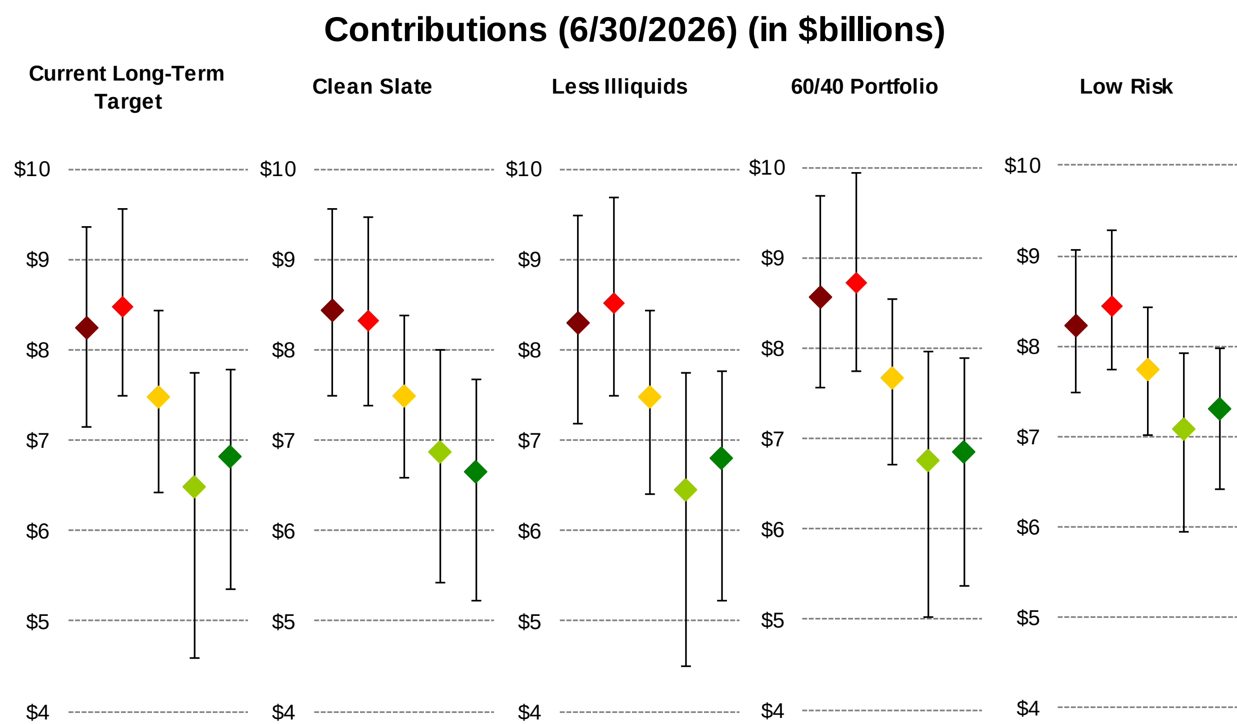
World events unfold in a fashion consistent with our Global Capital Market Assumptions

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 Takeaway:

- Higher allocations to return-seeking assets will lower the expected contributions in favorable economic conditions with potential for greater contributions in adverse conditions compared to lower risk portfolios

Asset-Liability Projection Results (Stochastic Results)

"What if?" Scenario Analysis | Net Outflow Analysis

Net Outflow Analysis (Benefit Payments - Contributions) / MVA (6/30/2026)

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

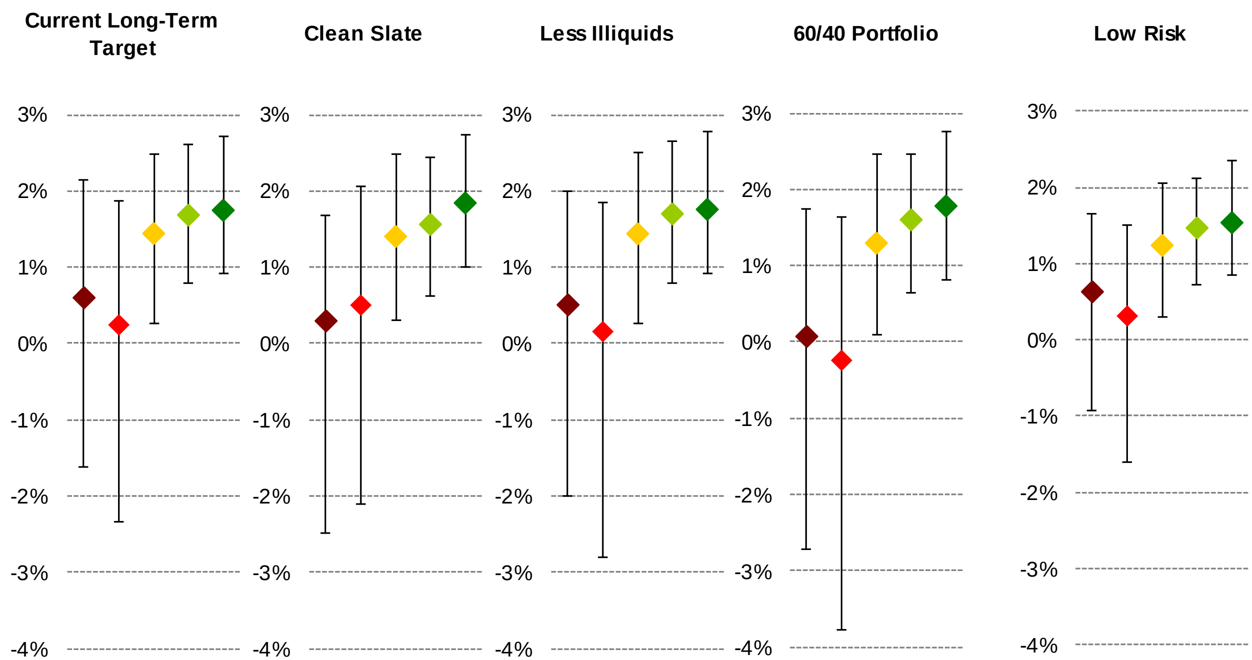
World events unfold in a fashion consistent w ith our Global Capital Market Assumptions

High Growth, High Inflation

Economy grow s more than expected mainly due to inflationary forces

High Growth, Low Inflation

Pronounced cyclical upsw ing w ith w orld Return-Seeking above and even substantially above long-term trend w hile inflation expectations remain contained



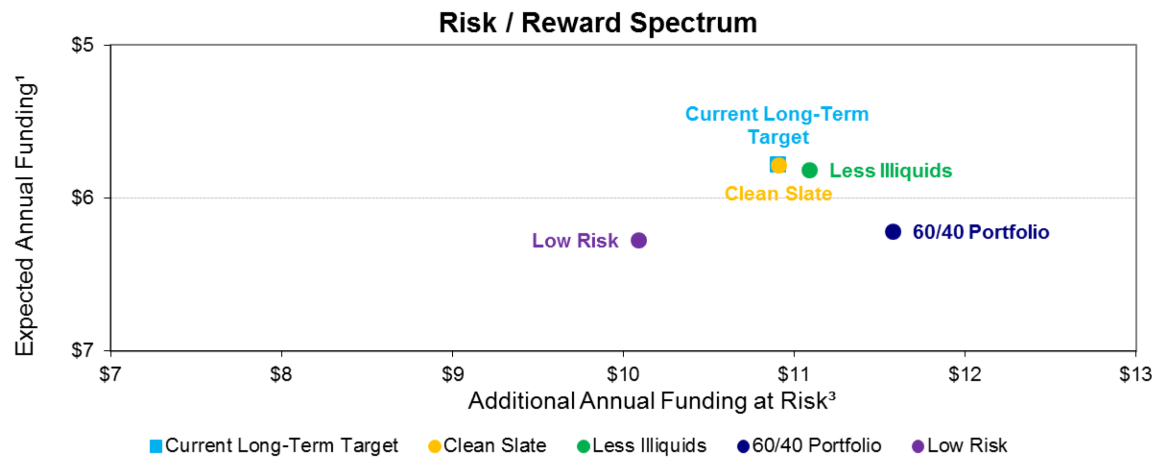
Key Takeaway:

- Portfolios with higher volatility will widen the distribution of net outflow outcomes in low and moderate growth environments compared to lower risk portfolios

Appendix

- Steady State Analysis – Investment vs. Funding

Steady State Analysis – Investment vs. Funding



	Modeling Metric					
	Expected Nominal Return	Shortfall Versus Required Return	Expected Annual Funding[1]	Expected Nominal Volatility	1-Year Downside Return[2]	Additional Annual Funding at Risk[3]
Current Long-Term Target	7.20%	11.60%	$5.8	10.90%	-3.08%	$10.9
Clean Slate	7.18%	11.62%	$5.8	10.88%	-3.09%	$10.9
Less Illiquids	7.13%	11.67%	$5.8	11.22%	-3.45%	$11.1
60/40 Portfolio	6.32%	12.48%	$6.2	11.44%	-4.44%	$11.6
Low Risk	6.21%	12.59%	$6.3	7.97%	-1.44%	$10.1

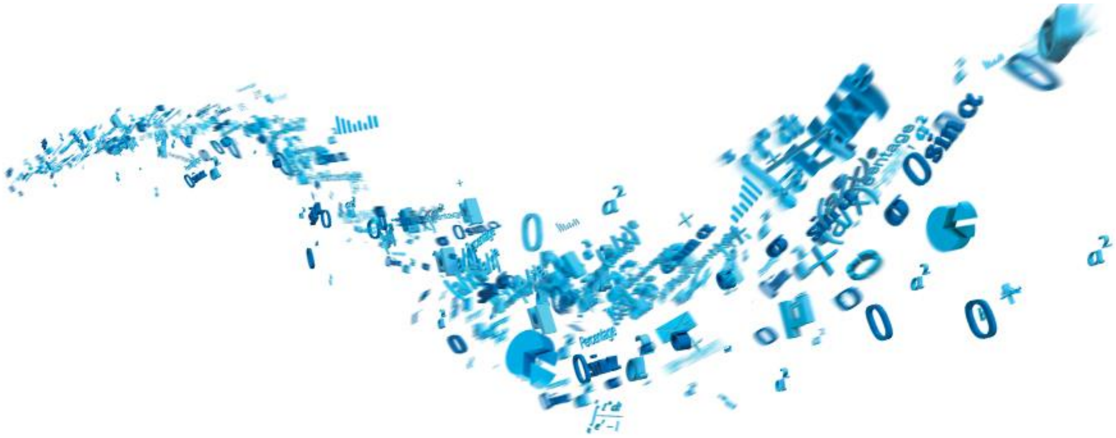
[1] Expected annual funding to maintain the current funded ratio is equal to the sum of the net interest cost and normal cost
[2] Expected annual return under a one standard deviation adverse event
[3] Additional annual funding under a one standard deviation adverse event to maintain current funded status

Key Takeaways:

- The growth rate required of the assets to keep pace with the liability growth (the "hurdle rate") is currently 18.8%:

Interest Cost	14.5%
Normal Cost	4.3%
Total	**18.8%**

- The hurdle rate is covered by a combination of investment returns and cash funding
- Higher allocations to return-seeking assets produce lower expected funding amounts, but with more volatility



Appendix

- Actuarial Assumptions and Methods

Actuarial Assumptions and Methods

- Actuarial assumptions:
  - Valuation Rate of Interest = 7.25% for all future years
  - Inflation = 2.75%
  - Salary Scale = effective average of 5.50% per year
  - Payroll Growth = 3.50% per year
  - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 10 years and shall be no less than 70% and no greater than 130% of the market value of assets
  - All other assumptions as documented in the Actuarial Valuation Report as of June 30, 2016
- Actuarially-Determined Contribution Calculation = Normal Cost plus a level percent amortization of the unfunded liability with layered 24 year, closed periods, and a 3.50% salary scale
  - Amortization bases developed are projected to continue until their individual expiry unless the plan reaches 100% funded on an actuarial value of assets basis
- Employee contributions are limited to the actuarially-determined contribution
- The health care premium assistance assets and liabilities have been excluded from this analysis
- The system's workforce size is assumed to remain constant over the projection period
- For Act 120 plan projection: Future new employees are assumed to be Class T-E members and have similar characteristics (age/gender/salary) to new employees for the period July 1, 2013 through June 30, 2016.
- For Act 5 plan projection: Future new employees as assumed in Conduent's May 23, 2017 cost note
- The rate collar provision of Act 120 was not considered in this analysis as it has been deemed to no longer be effective
- "Shared Risk" provisions of Act 120 have not been considered in this analysis

Appendix

- Capital Market Assumptions

AHIC Capital Market Assumptions
As of 2Q 2017 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.2%	6.5%	17.0%
2	Small Cap U.S. Equity	4.7%	7.0%	23.5%
3	International Equity (Developed) Hedged	5.2%	7.5%	18.5%
4	Emerging Markets Equity	5.2%	7.5%	30.5%
	Fixed Income			
5	Cash (Gov't)	0.6%	2.8%	2.0%
6	Cash (LIBOR)	1.1%	3.3%	2.0%
7	Global TIPS	0.8%	3.0%	3.5%
8	Core Fixed Income	1.5%	3.7%	5.0%
9	Private Debt	6.8%	9.2%	19.5%
10	Long Duration Bonds – Gov't	1.2%	3.4%	11.0%
11	High Yield Bonds	3.1%	5.4%	12.0%
12	Non-US Developed Bond (100% Hedged)	1.0%	3.2%	4.0%
13	Emerging Market Bonds	3.0%	5.3%	14.0%
14	Emerging Market Bonds (Sov. Local)	3.8%	6.1%	14.5%
	Alternatives			
15	Gold	1.0%	3.2%	19.5%
16	Real Estate (Broad Market)	3.2%	5.5%	12.5%
17	US REITs	3.9%	6.2%	19.0%
18	Commodities	3.2%	5.5%	17.0%
19	Private Equity	6.3%	8.6%	24.5%
20	Infrastructure (Private)	4.0%	6.3%	14.5%
21	Infrastructure (Public)	4.8%	7.1%	17.5%
22	Hedge Funds[2]	3.3%	5.6%	8.0%
23	Risk Parity[3]	3.8%	6.1%	12.0%
	Inflation			
	Inflation	0.0%	2.2%	1.5%

[1] All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees.
[2] Hedge Fund assumptions developed as follows: 16% Event Driven, 0% CTA, 38% Global Macro, 0% Distressed Debt, 37% Fixed Income Arbitrage, 9% Cat. Bonds
[3] Risk Parity assumption developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

AHIC Capital Market Assumptions
As of 2Q 2017 (30 Years)

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	Large Cap U.S. Equity	**1.00**	0.92	0.89	0.72	0.09	0.09	-0.05	0.05	0.40	-0.12	0.62	0.00	0.44	0.47	0.01	0.41	0.66	0.32	0.69	0.38	0.89	0.58	0.83
2	Small Cap U.S. Equity	0.92	**1.00**	0.82	0.67	0.08	0.07	-0.06	0.04	0.36	-0.12	0.57	0.00	0.41	0.42	0.01	0.38	0.61	0.27	0.65	0.35	0.83	0.53	0.77
3	International Equity (Developed) Hedged	0.89	0.82	**1.00**	0.73	0.10	0.10	-0.05	0.06	0.38	-0.11	0.58	0.00	0.42	0.41	0.01	0.42	0.60	0.27	0.62	0.35	0.85	0.52	0.79
4	Emerging Markets Equity	0.72	0.67	0.73	**1.00**	0.07	0.06	-0.05	0.05	0.37	-0.10	0.68	0.00	0.50	0.54	0.01	0.34	0.49	0.32	0.53	0.29	0.78	0.43	0.75
5	Cash (Gov't)	0.09	0.08	0.10	0.07	**1.00**	0.98	0.60	0.48	0.01	0.24	0.14	0.64	0.16	0.01	0.05	0.15	0.09	0.22	0.09	0.11	0.11	0.08	0.19
6	Cash (LIBOR)	0.09	0.07	0.10	0.06	0.98	**1.00**	0.59	0.48	0.02	0.24	0.14	0.63	0.17	0.01	0.04	0.14	0.09	0.21	0.09	0.11	0.11	0.08	0.17
7	Global TIPS	-0.05	-0.06	-0.05	-0.05	0.60	0.59	**1.00**	0.42	-0.05	0.22	0.07	0.42	0.10	-0.03	0.03	0.03	-0.02	0.23	-0.04	0.02	-0.01	0.01	0.20
8	Core Fixed Income	0.05	0.04	0.06	0.05	0.48	0.48	0.42	**1.00**	0.11	0.75	0.31	0.61	0.47	0.12	0.01	0.07	0.04	0.09	0.04	0.06	0.06	0.18	0.29
9	Private Debt	0.40	0.36	0.38	0.37	0.01	0.02	-0.05	0.11	**1.00**	-0.34	0.74	0.00	0.46	0.43	0.01	0.17	0.26	0.15	0.29	0.16	0.38	0.62	0.29
10	Long Duration Bonds – Gov't	-0.12	-0.12	-0.11	-0.10	0.24	0.24	0.22	0.75	-0.34	**1.00**	-0.14	0.50	0.13	-0.05	-0.02	-0.04	-0.08	-0.03	-0.10	-0.04	-0.11	-0.08	0.09
11	High Yield Bonds	0.62	0.57	0.58	0.68	0.14	0.14	0.07	0.31	0.74	-0.14	**1.00**	0.10	0.73	0.58	0.03	0.28	0.41	0.39	0.46	0.27	0.65	0.61	0.67
12	Non-US Developed Bond (100% Hedged)	0.00	0.00	0.00	0.00	0.64	0.63	0.42	0.61	0.00	0.50	0.10	**1.00**	0.24	0.07	0.02	0.06	0.01	0.10	0.00	0.05	0.01	0.09	0.10
13	Emerging Market Bonds	0.44	0.41	0.42	0.50	0.16	0.17	0.10	0.47	0.46	0.13	0.73	0.24	**1.00**	0.61	0.01	0.20	0.29	0.22	0.32	0.19	0.46	0.55	0.51
14	Emerging Market Bonds (Sov. Local)	0.47	0.42	0.41	0.54	0.01	0.01	-0.03	0.12	0.43	-0.05	0.58	0.07	0.61	**1.00**	0.01	0.12	0.28	0.46	0.20	0.12	0.56	0.47	0.60
15	Gold	0.01	0.01	0.01	0.01	0.05	0.04	0.03	0.01	0.01	-0.02	0.03	0.02	0.01	0.01	**1.00**	0.01	0.01	0.05	0.02	0.02	0.02	0.02	0.03
16	Real Estate (Broad Market)	0.41	0.38	0.42	0.34	0.15	0.14	0.03	0.07	0.17	-0.04	0.28	0.06	0.20	0.12	0.01	**1.00**	0.49	0.09	0.34	0.20	0.41	0.23	0.34
17	US REITs	0.66	0.61	0.60	0.49	0.09	0.09	-0.02	0.04	0.26	-0.08	0.41	0.01	0.29	0.28	0.01	0.49	**1.00**	0.19	0.47	0.27	0.68	0.37	0.54
18	Commodities	0.32	0.27	0.27	0.32	0.22	0.21	0.23	0.09	0.15	-0.03	0.39	0.10	0.22	0.46	0.05	0.09	0.19	**1.00**	0.11	0.08	0.49	0.33	0.65
19	Private Equity	0.69	0.65	0.62	0.53	0.09	0.09	-0.04	0.04	0.29	-0.10	0.46	0.00	0.32	0.20	0.02	0.34	0.47	0.11	**1.00**	0.32	0.61	0.38	0.54
20	Infrastructure (Private)	0.38	0.35	0.35	0.29	0.11	0.11	0.02	0.06	0.16	-0.04	0.27	0.05	0.19	0.12	0.02	0.20	0.27	0.08	0.32	**1.00**	0.34	0.21	0.31
21	Infrastructure (Public)	0.89	0.83	0.85	0.78	0.11	0.11	-0.01	0.06	0.38	-0.11	0.65	0.01	0.46	0.56	0.02	0.41	0.68	0.49	0.61	0.34	**1.00**	0.55	0.88
22	Hedge Funds[1]	0.58	0.53	0.52	0.43	0.08	0.08	0.01	0.18	0.62	-0.08	0.61	0.09	0.55	0.47	0.02	0.23	0.37	0.33	0.38	0.21	0.55	**1.00**	0.53
23	Risk Parity[2]	0.83	0.77	0.79	0.75	0.19	0.17	0.20	0.29	0.29	0.09	0.67	0.10	0.51	0.60	0.03	0.34	0.54	0.65	0.54	0.31	0.88	0.53	**1.00**

[1] Hedge Fund assumptions developed as follows: 16% Event Driven, 0% CTA, 38% Global Macro, 0% Distressed Debt, 37% Fixed Income Arbitrage, 9% Cat. Bonds
[2] Risk Parity assumption developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

Appendix

- Public Pension Peer Comparison

Public Pension Peer Comparison
Overview

- Public Fund Peer Asset Allocation Comparison
  - Asset allocation should be matched to each defined benefit plan's unique design
  - Peer comparison is meant to inform and not dictate policy

Public Pension Peer Comparison

PSERS' Asset Allocation versus Public Peers

Asset Allocation	PSERS	Large Public Pension Plans ($1-5B)*	Large Public Pension Plans (>$5B)*	Total Public Pension Universe*	Wilshire Report on State Retirement Systems **	AHIC Public Peer Average ***
Equity Exposure						
Global Equity	0.0%	5.5%	8.2%	7.9%		45.5%
Total U.S. Equity	7.8%	25.1%	21.7%	22.1%	27.3%	
Total Int'l Equity	12.2%	16.5%	16.1%	16.2%	20.1%	
Private Markets	15.0%	5.0%	9.4%	9.0%	10.0%	12.1%
Total Equity	***35.0%***	***52.1%***	***55.4%***	***55.2%***	***57.4%***	***57.6%***
Fixed Income Exposure						
U.S. Fixed Income	10.0%	19.3%	21.4%	21.4%	21.1%	
High Yield Bonds / Private Debt	8.0%					
Non-US Developed Bonds	1.0%	3.4%	3.5%	3.5%	2.3%	
Emerging Market Debt	2.0%	0.9%	1.3%	1.2%		
Inflation Protected	15.0%					
Total Fixed Income	***36.0%***	***23.6%***	***26.2%***	***26.1%***	***23.4%***	***21.3%***
Real Asset Exposure						
US Infrastructure (Public + Private)	8.0%	0.5%	0.4%	0.4%		
Commodities / Gold	8.0%	2.2%	0.9%	1.0%		
Real Estate	10.0%	8.6%	9.0%	9.0%	8.1%	
Total Real Assets	***26.0%***	***11.3%***	***10.3%***	***10.4%***	***8.1%***	***12.9%***
Hedge Funds / Opportunistic	10.0%	4.5%	4.1%	4.2%		5.8%
Multi-Asset / Risk Parity	10.0%	4.4%	0.7%	1.0%		2.3%
Money Market / Cash	3.0%	0.8%	1.1%	1.1%		0.4%
Leverage	-20.0%					
Other	0.0%	3.2%	2.0%	2.1%	11.1%	
Net Other	***3.0%***	***12.9%***	***7.9%***	***8.4%***	***11.1%***	***8.5%***
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***
Expected Return	***7.20%***	***6.26%***	***6.49%***	***6.48%***	***6.06%***	***6.86%***
Expected Volatility	***10.90%***	***11.23%***	***11.56%***	***11.55%***	***11.17%***	***12.35%***
Sharpe Ratio	***0.404***	***0.308***	***0.319***	***0.319***	***0.292***	***0.329***

* Source: "*2016 U.S. Institutional Market Trends*", Greenwich Associates

** Source: *"2016 Report on State Retirement Systems: Funding Levels and Asset Allocation"*, Wilshire Consulting

*** Source: AHIC Public Peer Average is based on a universe of AHIC's 11 largest public pension plans with total assets ranging from $14B–$142B

Appendix

- Investment Guidance for Public Employee Retirement System Trustees

Aon
Empower Results®

Investment Guidance for Public Employee Retirement System Trustees[1]

1. **PERS trustees should look to the state for statutory direction on behalf of the taxpayers**
   a) Prudent-person rule
   b) Peer analysis

2. **PERS trustees should not be daunted by a liability value that exceeds the value of assets**
   a) Do not feel obliged to incur greater risk in an effort to narrow the gap
   b) Funded status has less to do with investment performance than it does with public policy and politics

3. **PERS trustees should not assume that an equity-oriented investment policy is suitable for their fund**
   a) Discern the risk tolerance of taxpayers
   b) May conclude that a moderate level of risk is warranted

4. **Trustees of individual PERSs should be cognizant of the existence and implications of the unitary state pension fund**
   a) Unitary state pension fund is the only fund of economic consequence to the taxpayers
   b) Multiple actively managed funds may form, in total, a closet index fund

5. **PERS investments should be exposed to rewarded risks, and insulated from unrewarded risks**
   a) Market risk (equity exposure) is rewarded risk, on average
   b) Diversifiable risk is not

[1] Richard M. Ennis, *Is a Statewide Pension Fund a Person or a Cookie Jar? The Answer Has Implications for Investment Policy,* Financial Analysts Journal, November-December 1988

Appendix

- Horizon Survey of Capital Market Assumptions

Capital Market Assumption Overview

- The following slides include a review of 2016 assumptions relative to a study of peer averages
  - AHIC is often more conservative from an expected return standpoint than the peer average
  - While we do 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

2016 Horizon Survey Results
AHIC vs. Other Advisors

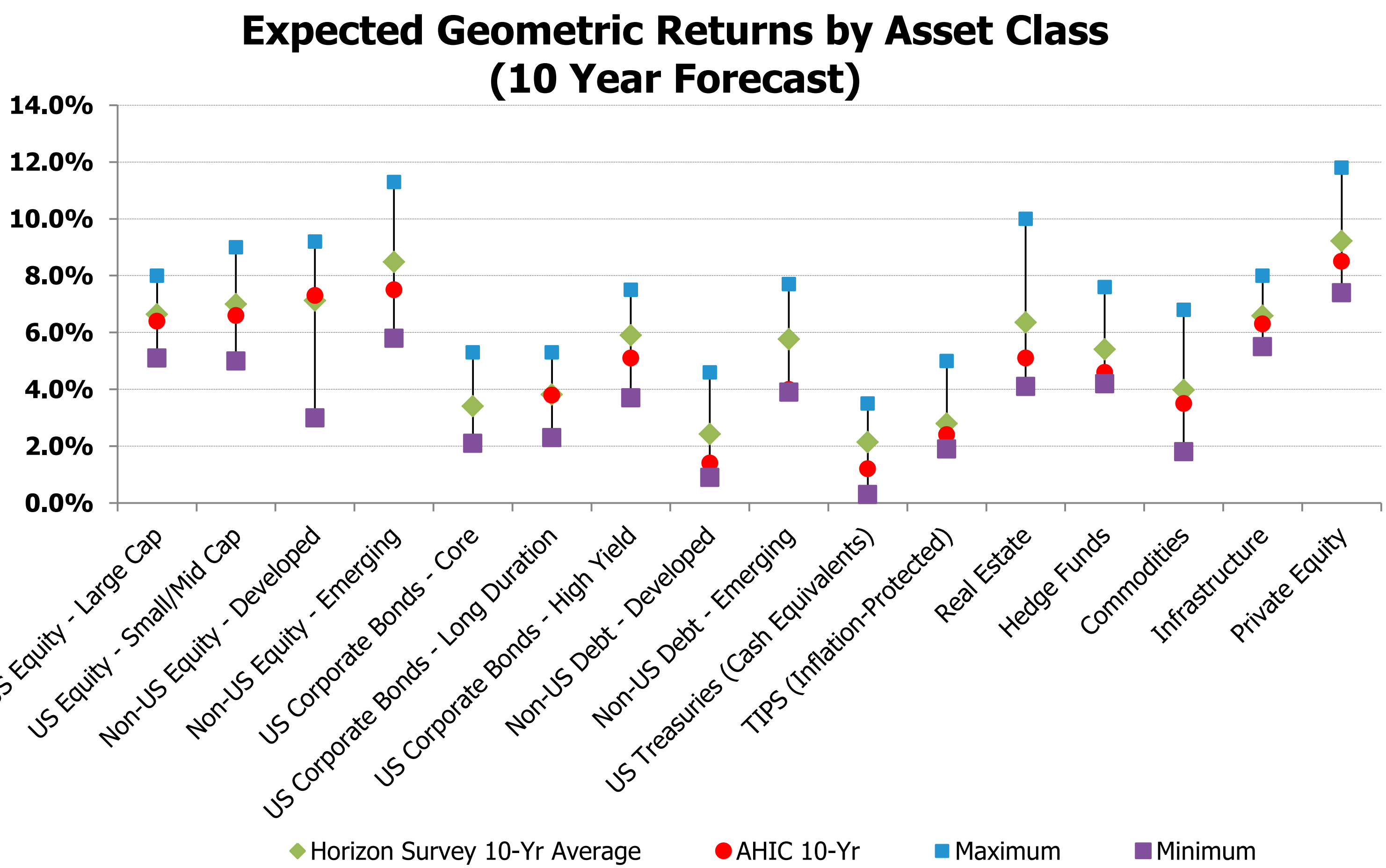
- The 2016 Horizon Survey generally showed return expectations slightly lower in 2016 than 2015
  - Equity return assumptions are lower by an average of 0.1%
  - Fixed income return assumptions are higher by an average of 0.1%
  - Alternative asset class return assumptions are lower by an average of 0.1%

- 2016 AHIC 10-year forecast assumptions tend to be similar to the survey average in some asset classes (e.g., public equities), and somewhat lower in others (e.g., alternatives)
  - AHIC equity assumptions are driven by market valuations, earnings growth expectations and assumed payouts to investors. Recent experience suggests strong equity market performance has been driven more by increasing valuations than increasing profits. As markets have become more expensive, our equity return assumptions have consequently fallen
  - AHIC fixed income assumptions reflect falling yields and flattening of yield curves during the first two quarters of 2016
  - AHIC alternative asset class assumptions are generally lower due to methodological and inflation forecast differences compared to survey participant forecasts

- In conclusion, AHIC assumptions appear somewhat more conservative than peers included in the 2016 Horizon Survey of capital market assumptions

2016 Horizon Survey Results

Distribution of Expected Returns from 35 Consultants



SOURCE: Horizon Actuarial survey of 2016 capital market assumptions from 35 independent investment advisors
Expected returns of the survey are annualized over 10 years (geometric).
AHIC expected returns are annualized over 10 years as of June 30, 2016

2016 Horizon Survey Results
AHIC Versus Peers

Asset Class	Horizon Survey: Expected Geometric Returns (10-Yr) Maximum	Minimum	Average	Expected Risk Average	AHIC 10 Year Forecasts: Expected Return	Expected Risk	AHIC 30 Year Forecasts: Expected Return	Expected Risk
US Equity - Large Cap	8.0%	5.1%	6.6%	16.9%	6.4%	17.0%	6.3%	17.0%
US Equity - Small/Mid Cap	9.0%	5.0%	7.0%	21.0%	6.6%	23.0%	6.8%	23.5%
Non-US Equity - Developed	9.2%	3.0%	7.1%	19.5%	7.3%	20.0%	7.2%	20.0%
Non-US Equity - Emerging	11.3%	5.8%	8.5%	26.4%	7.5%	30.0%	7.5%	30.5%
US Fixed Income - Core	5.3%	2.1%	3.4%	6.0%	2.1%	3.5%	2.9%	5.0%
US Fixed Income - Long Duration Corp	5.3%	2.3%	3.8%	10.5%	3.8%	11.5%	4.0%	15.0%
US Fixed Income - High Yield	7.5%	3.7%	5.9%	11.0%	5.1%	12.0%	5.4%	12.0%
Non-US Fixed Income - Developed	4.6%	0.9%	2.4%	7.6%	1.4%	5.5%	2.2%	6.5%
Non-US Fixed Income - Emerging	7.7%	3.9%	5.8%	11.6%	4.0%	13.0%	4.9%	13.5%
Treasuries (Cash Equivalents)	3.5%	0.3%	2.1%	2.8%	1.2%	1.0%	1.9%	2.0%
TIPS (Inflation-Protected)	5.0%	1.9%	2.8%	6.5%	2.4%	4.5%	3.1%	4.5%
Real Estate	10.0%	4.1%	6.4%	14.7%	5.1%	11.5%	5.1%	11.5%
Hedge Funds	7.6%	4.2%	5.4%	8.4%	4.6%	9.0%	5.0%	9.5%
Commodities	6.8%	1.8%	4.0%	18.5%	3.5%	17.0%	4.4%	17.0%
Infrastructure	8.0%	5.5%	6.6%	13.8%	6.3%	14.5%	6.6%	14.5%
Private Equity	11.8%	7.4%	9.2%	23.1%	8.5%	24.0%	8.5%	24.5%
Inflation			2.2%	1.8%	2.1%	1.0%	2.1%	1.5%

Notes (Horizon Survey):
Source: Horizon Actuarial survey of 2016 capital market assumptions from 35 independent investment advisors
Expected returns are annualized (geometric).

Notes (AHIC Forecasts):
AHIC Forecasts are as of June 30, 2016
US Equity - Small/Mid Cap forecasts represents AHIC forecasts for US Small Cap
US Fixed Income - Long Duration forecasts represents AHIC forecasts for Long Duration Credit
Non-US Fixed Income - Developed forecasts represents AHIC forecasts for Non-US Fixed Income - Developed (50% Hedged)
Non-US Fixed Income- Emerging forecasts represents AHIC forecasts for Non-US Fixed Income- Emerging Sovereign USD
Real Estate forecasts represents AHIC forecasts for Core Private Real Estate
Hedge Funds forecasts represents AHIC forecasts for Hedge Fund-of-Funds (Buy List)

2016 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 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 based on indexed returns (no “alpha”). However, AHIC return assumptions for certain asset classes include “alpha” or active management premium (e.g., Private Equity and Hedge Funds)

Appendix

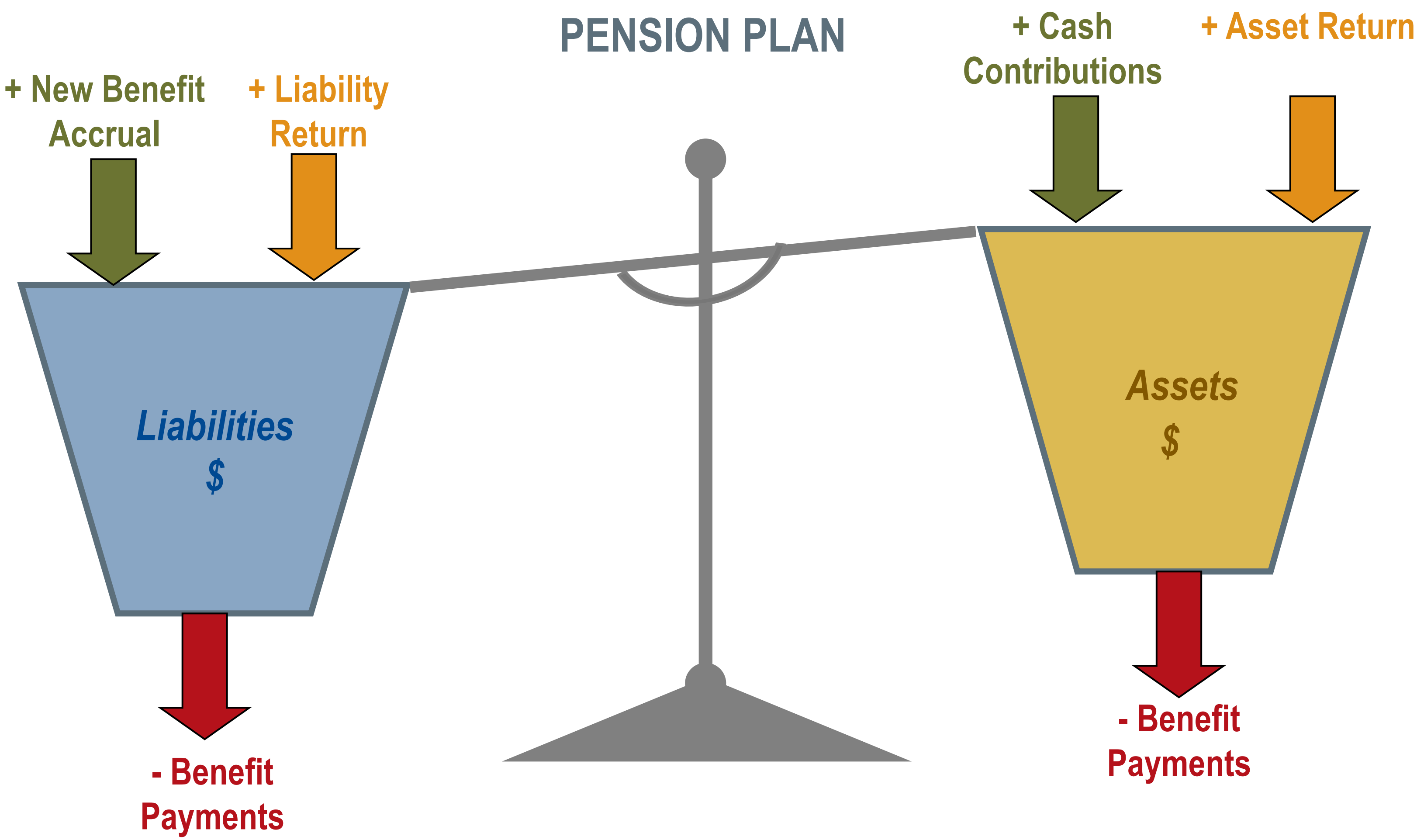
- Asset-Liability Management Background

Asset-Liability Management Background
What is an Asset-Liability Study?

- Provides fiduciaries with an understanding of the dynamic relationship between plan assets and liabilities over time
- Illustrates the impact of various asset allocation targets on required contributions and funded status under a range of different macro-economic scenarios
- Identifies future trends in the financial health of the plan based on economic uncertainties that may not be evident from an actuarial valuation, which provides only a snapshot at a point in time
- Helps determine the level of risk that is appropriate in the context of the Plan's liabilities

An asset-liability study provides the tools to align a plan's risk taking with its liabilities

Asset-Liability Management Background
Balance of Liabilities and Assets



Asset-Liability Management Background

Key Risks for Public Pension Plans

Types of Risk	Time Horizon	Risk Management Tools and Controls
Return Shortfall ▪ Assets do not grow with liabilities ▪ Investment return & contribution less than liability growth	**Long-Term** (10+ years)	▪ Funding policy ▪ Plan design ▪ Investment policy ▪ Assumptions & methods
Liquidity ▪ Cannot liquidate assets efficiently to meet needs ▪ Lose control of asset allocation	**Short- to Medium-Term** (<5 years)	▪ Funding policy ▪ Benefit accruals ▪ Use of Illiquid investments ▪ Scenario analysis ▪ Monitoring
Investment ▪ Asset allocation (policy) ▪ Investment structure ▪ Manager selection ▪ Rebalancing ▪ Scenario (or path risk) ▪ Factor	**Short-to Medium-Term** (<5 years)	▪ Investment policy statement – Static/dynamic – Asset allocation – Rebalancing – Manager guidelines – Monitoring/roles & responsibilities ▪ Risk budgeting ▪ Monitoring / dashboards ▪ Medium term views ▪ Regression and scenario analysis

Asset-Liability Management Background
Overview of the Asset-Liability Study Process

Planning Discussions

Planning
- Objectives of the Study
- Modeling and Liability Assumptions

+

Risk Tolerance
- Risk Preference
- Demographics
- Funded Status
- Business/Financial
- Industry Practices

+

Asset-Liability Projections

Asset Modeling
- Capital Market Analysis
- Efficient Frontier Analysis
- Portfolios for Study

+

Liability Analysis
- Cost Projections
- Funded Status
- Sensitivity Analysis

Desired Outcomes:
- **Understand the pension risk**
- **Identify optimal investment strategy**

Implementation

Monitoring & Execution

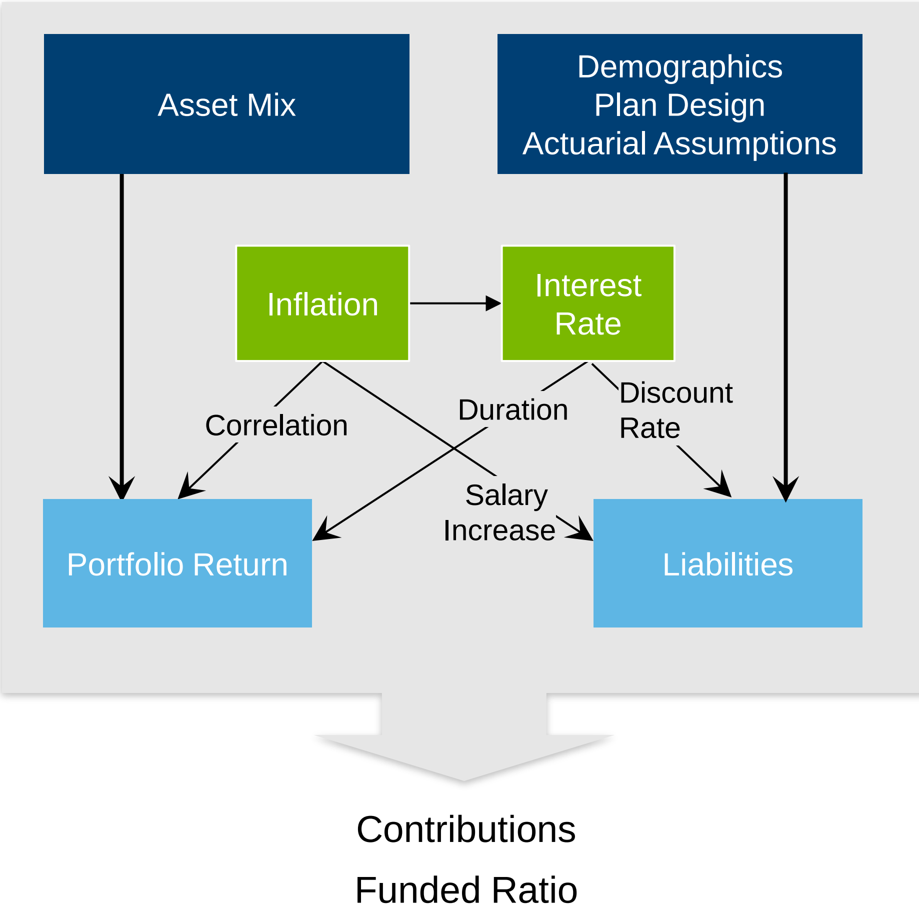
Asset-Liability Management Background
Modeling Process

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

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

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

Asset-Liability Management Background
Mechanics of Asset-Liability Modeling Process



Asset and liability modeling integrated in single platform

- Integrates impact of key economic variables

Flexibility in modeling parameters and output to client preferences

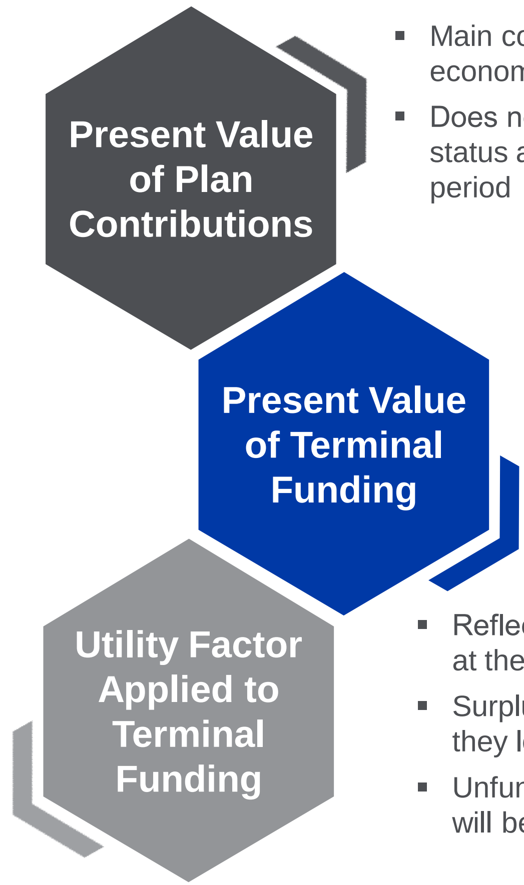
Stochastic and deterministic modeling performed

Asset-Liability Management Background
Long-Term Economic Cost of Plan

Long-Term Economic Cost =

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

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



- Main component of long-term economic cost
- Does not reflect the plan's funded status at the end of the forecast period

- Reflects the plan's funded status at the end of the forecast period
- Surplus assets are valuable as they lower future contributions
- Unfunded liabilities are costs that will be recognized in future years

Asset-Liability Management Background
Utility Factor For Terminal Funded Status

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

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

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

Asset-Liability Management Background
Risk and Return in an Asset-Liability Context

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

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

Asset-Liability Management Background
Key Factors Affecting the Risk/Reward Trade-off

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

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

Asset-Liability Management Background
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
- **Economic Cost** – Present Value of forecasted future contributions + Funding Shortfall / (Surplus)
- **Liability Growth Rate –** the projected growth of the liability over the coming year as measurement by the sum of the Normal Cost (new benefit accruals) and Interest Cost (one year of discounting)
- **MVA** = Market Value of Assets (i.e., un-smoothed / economic reality)
- **Return-Seeking Assets ("R-S")** – All non "Safety" assets
  - Return-Seeking assets are further divided into three categories:
    - **Equity returns** – asset classes that provide exposure to the equity risk premium
    - **Diversified returns** – asset classes that provide exposure to other market risk premiums
    - **Skill** – asset classes that rely on manager skill (rather than market risk premiums) to drive returns
- **Safety Assets** – Assets where the primary function is risk control / downside mitigation.
- **Target Mix** – the allocation of assets between Return-Seeking Assets and Safety Assets

Appendix

- About This Material

About This Material

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

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

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

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

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 2016 actuarial valuation for PSERS 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 June 30, 2016.

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 associate of Aon Hewitt Investment Consulting, Inc. providing services to PSERS has any direct financial interest or indirect material interest in PSERS. Thus, we believe there is no relationship existing that might affect our capacity to prepare and certify this report for PSERS.

Aon Hewitt Investment Consulting, Inc.

Phil Kivarkis FSA, CFA

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ATTN: AHIC Compliance Officer

About Aon Hewitt

Aon Hewitt empowers organizations and individuals to secure a better future through innovative talent, retirement and health solutions. We advise, design and execute a wide range of solutions that enable clients to cultivate talent to drive organizational and personal performance and growth, navigate retirement risk while providing new levels of financial security, and redefine health solutions for greater choice, affordability and wellness. Aon Hewitt is a global leader in human resource solutions, with over 30,000 professionals in 90 countries serving more than 20,000 clients worldwide. For more information, please visit aonhewitt.com.