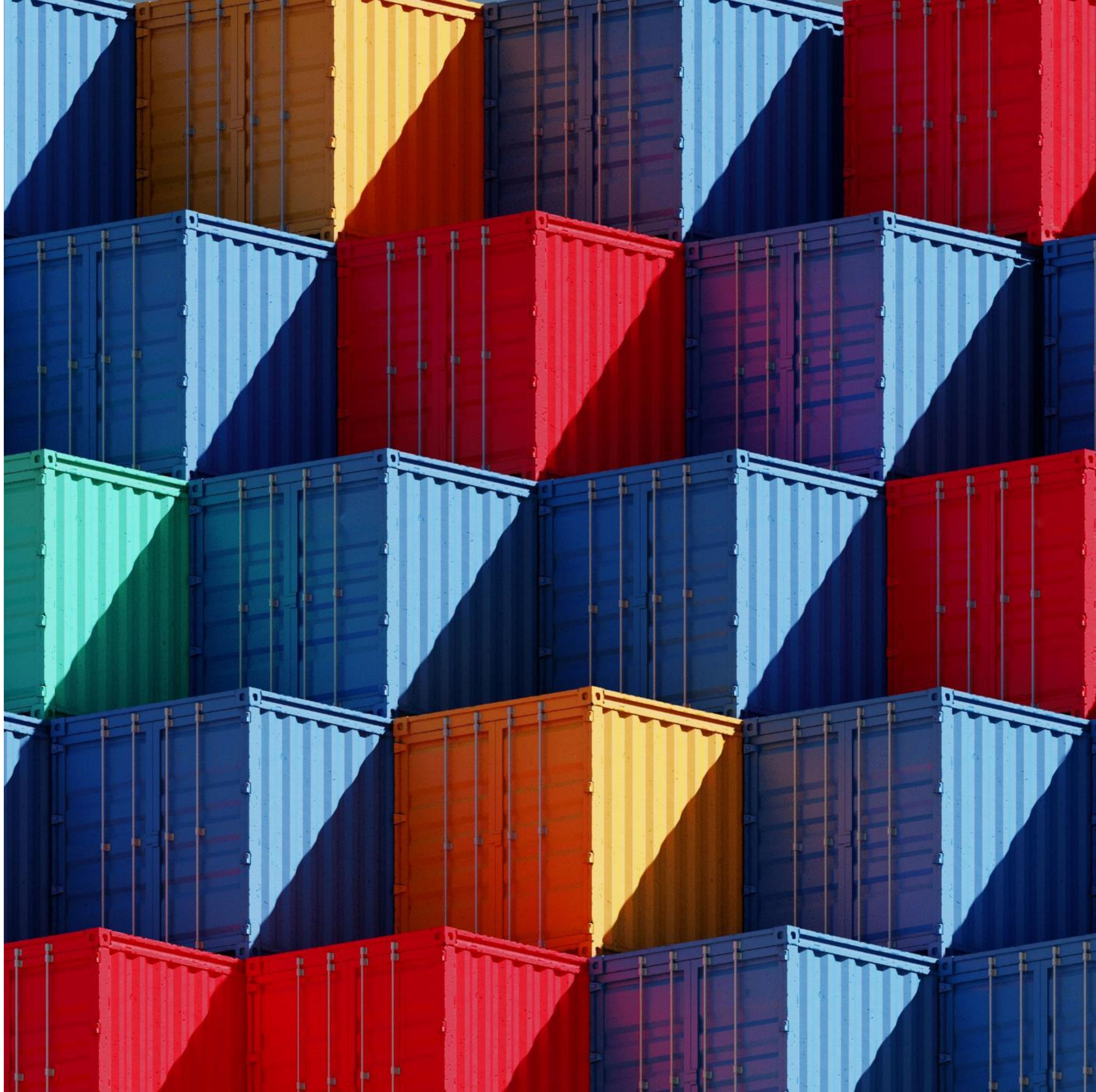
Asset-Liability Study Update

Colorado Public Employees' Retirement Association (PERA)

January 19, 2024



Asset–Liability Study Progress Report

Coordinating with PERA investment team; Validated model with plan actuary

Key steps completed:

- Meetings with Board (9/22, 11/17) to develop project plan and report progress
- Meetings with PERA investment team (10/18, 10/31, 12/19) to discuss capital market assumptions and portfolio ideas
- Meeting with Segal (1/8) to validate asset-liability projection model

Goals for today:

- Discuss initial projection results
- Preview additional portfolios for study
- Address questions on capital market assumptions

Suggested next steps:

- Additional meeting(s) with PERA investment team to validate capital market assumptions and portfolio ideas
- Analysis of additional portfolios, including impact on projected financials for March Board meeting
- Finalize analysis and conclusions for June Board meeting

Projected Timeline

Present results to Board in June 2024

Meeting	Key Decision Points	Participants	Target Dates*
Planning Meeting	▪ Set timeline ▪ Define key metrics ▪ Discuss Board objectives ▪ Assess initial portfolio ideas ▪ Discuss assumptions	▪ Aon ▪ PERA Staff ▪ PERA Board	*September 2023*
Portfolio Meetings	▪ Refine constraints ▪ Determine portfolios for further study	▪ Aon ▪ PERA Staff	*October 2023 – January 2024*
Initial Results	▪ Model validation, discussion with plan actuary ▪ Identify “best ideas” ▪ Specify additional analysis	▪ Aon ▪ Segal ▪ PERA Staff ▪ PERA Board	*January 2024 – May 2024*
Board of Trustees Presentation	▪ Strategic asset allocation recommendations and rationale ▪ Select strategy ▪ Implementation considerations	▪ Aon ▪ PERA Staff ▪ PERA Board	*June 2024*
Post-Study Process	▪ Review active risk management and incentive compensation ▪ Implementation details ▪ Transition portfolio	▪ Aon ▪ PERA Staff	*Post-Study*

*Subject to change

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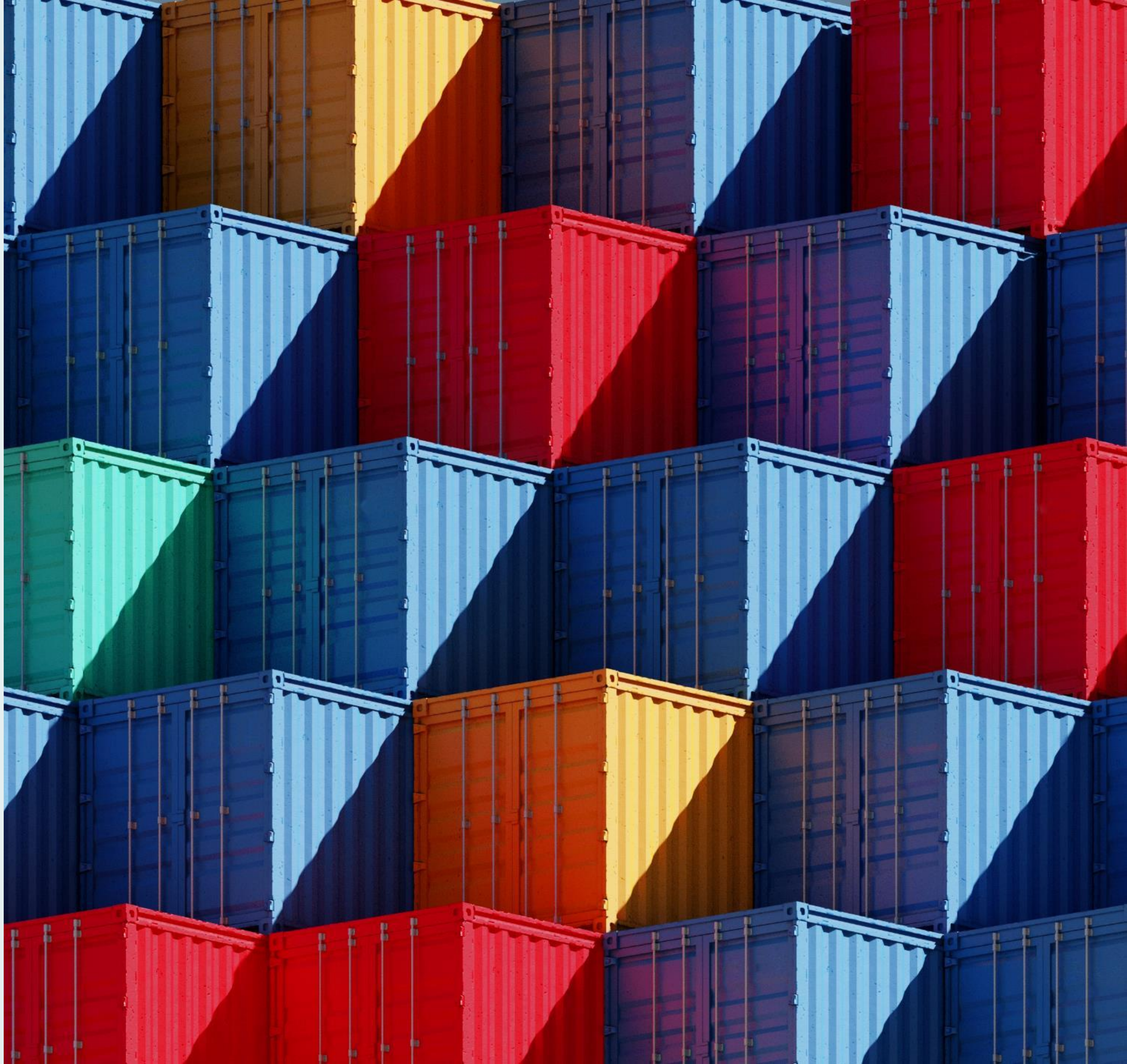
Initial Projection Results



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Colorado PERA Current State

Aggregate of 5 division trusts estimated to be 63% funded as of September 30, 2023

Asset-Liability Snapshot ($, Billions) Aggregate of 5 division trusts	**12/31/2022**	**Estimated 9/30/2023**
Actuarial Liabilities[1]	$87.2	$88.7
Estimated Market Value of Assets[2]	$54.7	$56.1
Market Value of Assets Funded Ratio	62.7%	63.2%
Actuarial Value of Assets	$60.9	
Actuarial Value of Assets Funded Ratio	69.9%	

Target Asset Allocation ($, Billions)	**Target %**	**Estimated 9/30/2023**
Return-Seeking Assets		
- Public Equity	54%	$30.3
- Private Equity	9%	$4.8
- Liquid Alternatives	2%	$0.9
- Core Real Estate	4%	$2.4
- Non-Core Real Estate	4%	$2.4
- Other Real Assets[3]	2%	$0.9
- Opportunity	3%	$1.5
- Total Return-Seeking Assets	**77%**	**$43.2**
Risk-Reducing Assets		
- Core Bonds	23%	$12.9
- Total Risk-Reducing Assets	**23%**	**$12.9**
Total	**100%**	**$56.1**

Key Observations:

- The starting point of the asset-liability study is the December 31, 2022 actuarial valuation
- Incorporating market experience through September 30, 2023 is expected to increase the funded ratio modestly
- The Actuarial Value of Assets (AVA) smooths investment gains/losses over four years and is a component in setting funding of the division trusts
  - There are historical investment losses that have not yet been smoothed into the AVA calculation, creating potential headwinds for the AAP

[1] Liability values as of September 30, 2023 based on actuarial projections provided by plan actuary as of 12/31/2022 projected on an open group basis
[2] Total assets as of September 30, 2023 based on the 12/31/2022 market value of assets in the actuarial valuation report projected forward based on a year-to-date asset return of 5.8% and pro-rated expected contributions, benefit payments, and expenses in the actuarial projections provided by the plan actuary.
[3] Other real assets modeled as 50% infrastructure / 25% timber / 25% farmland
Values may not sum due to rounding

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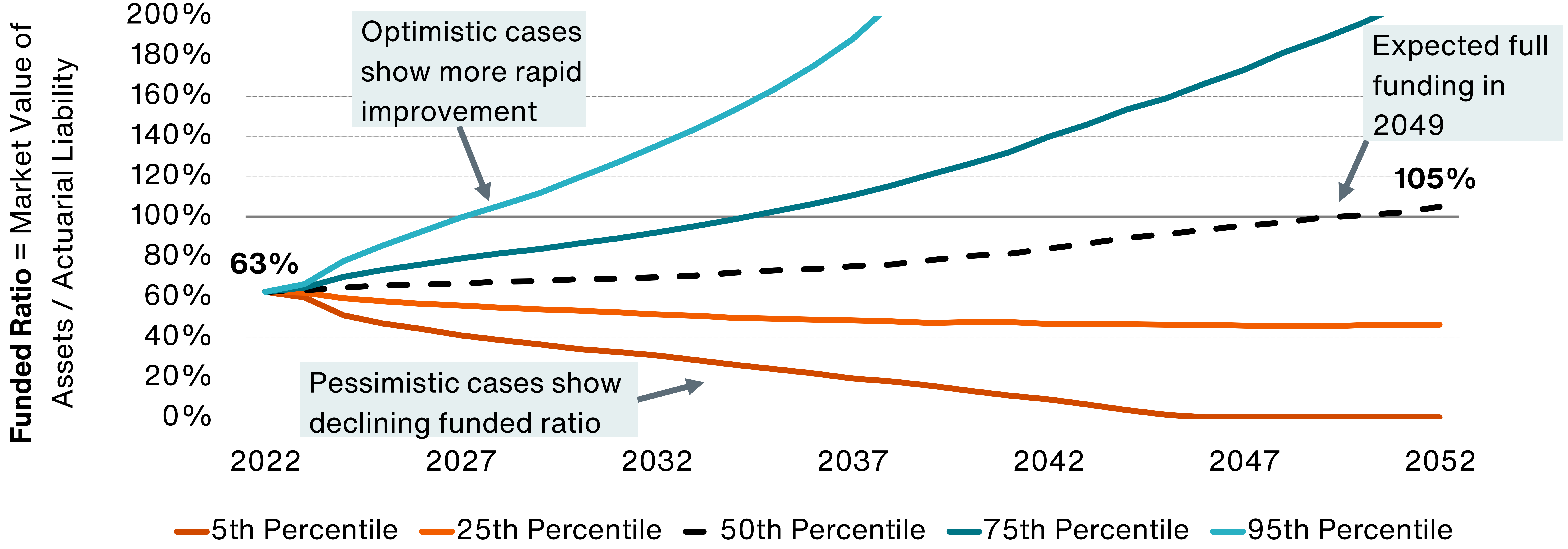
Projected Funded Ratio (Market Value of Assets Basis)

Expected full funding in 2049 with significant dispersion



Strategy	Current Policy (77% R-S)		
Year	**2032**	**2042**	**2052**
5th Percentile	31%	9%	0%
25th Percentile	51%	47%	46%
50th Percentile	70%	84%	105%
75th Percentile	92%	140%	>200%
95th Percentile	135%	>200%	>200%
Probability > 100%	21%	43%	52%

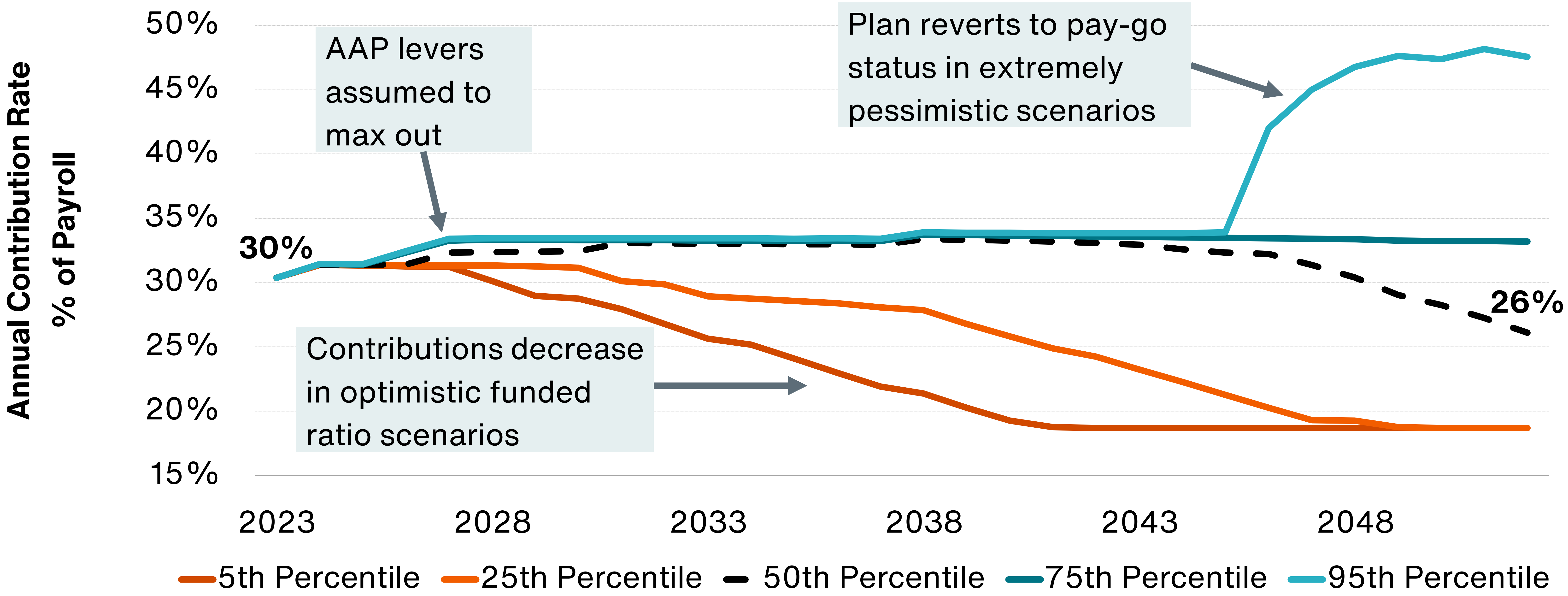
Projections assume a constant 7.25% discount rate for pension liabilities for all investment policies studied and reflect actual investment returns through September 30, 2023. Projections in this material include estimated expenses paid from plan assets, estimated to be $44.1 million for fiscal year ending 12/31/2023, which is assumed to be inclusive of investment management fees. These are increased with inflation for projection purposes. Actual fees and expenses may differ from those presented.

Key Observations

- Median (50th percentile) case demonstrates expected full funding in 2049 with significant dispersion due to economic risks
- Optimistic (75th and 95th percentile) cases demonstrate potential of full funding much sooner
- Pessimistic (25th and 5th percentile) cases demonstrate potential decline in funded ratio

Projected Contribution Rate

Expected contribution rates gradually increase to maximum amount under AAP



Strategy	Current Policy (77% R-S)		
Year	**2032**	**2042**	**2052**
5th Percentile	27%	19%	19%
25th Percentile	30%	24%	19%
50th Percentile	33%	33%	26%
75th Percentile	33%	34%	33%
95th Percentile	33%	34%	48%

Projections assume a constant 7.25% discount rate for pension liabilities for all investment policies studied and reflect actual investment returns through September 30, 2023. Projections in this material include estimated expenses paid from plan assets, estimated to be $44.1 million for fiscal year ending 12/31/2023, which is assumed to be inclusive of investment management fees. These are increased with inflation for projection purposes. Actual fees and expenses may differ from those presented.

Key Observations

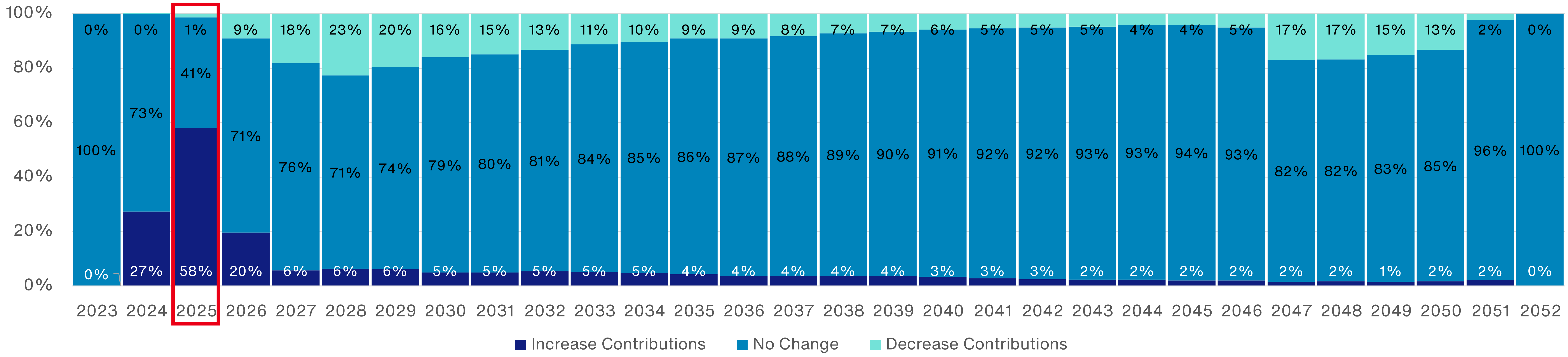
- Median (50th percentile) case contribution rate increases initially due to Automatic Adjustment Provision, then is limited by the maximum statutory rate
- Optimistic (25th and 5th percentile) cases project decreasing contribution rates due to the provisions lowering employer and employee contributions, the direct distribution, and the AED/SAED components

Automatic Adjustment Provision ("AAP") Metrics

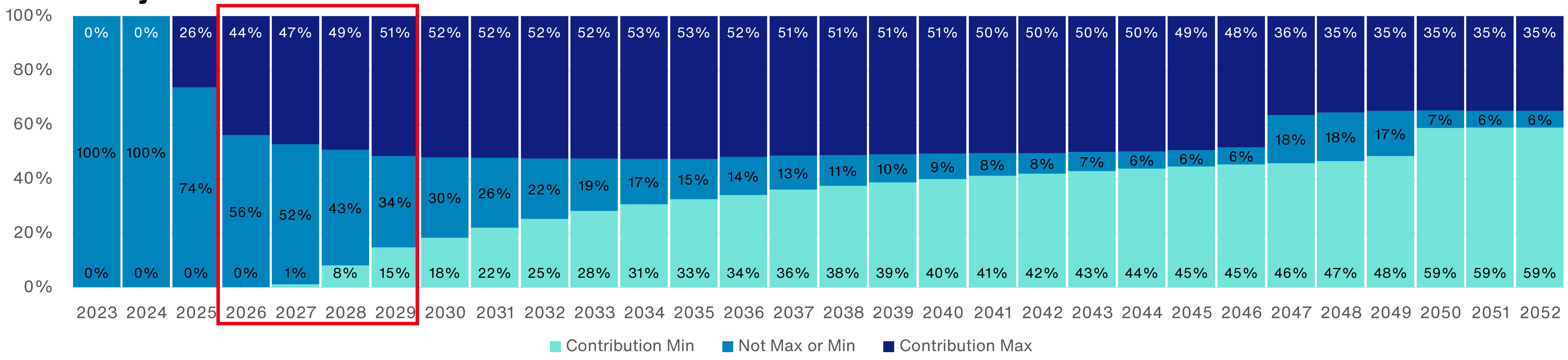
58% probability of triggering the AAP contribution increase at 12/31/2025

~50% probability of AAP triggering maximum contribution rates by 2029

Probability of Change in Employer and Employee Contribution Rates from AAP



Probability of Contributions at Maximum or Minimum Boundaries from AAP



Projections assume a constant 7.25% discount rate for pension liabilities for all investment policies studied and reflect actual investment returns through September 30, 2023. Projections in this material include estimated expenses paid from plan assets, estimated to be $44.1 million for fiscal year ending 12/31/2023, which is assumed to be inclusive of investment management fees. These are increased with inflation for projection purposes. Actual fees and expenses may differ from those presented. Percentages may not sum to 100% due to rounding.

Key Observations

- Upper chart demonstrates projected probabilities of triggering AAP contribution rate change each year, reflecting any triggers hit in prior years
- Lower chart demonstrates projected probabilities of AAP contribution rates at the statutory max or min
- For example- since two subsequent contribution rate increases can result in contribution rates at the statutory maximum, an additional trigger when the contribution rate is already at max will result in "no change" in the upper chart

Initial Projection Results
Observations and Next Steps

Observations:

- Expect full funding by 2049 with significant dispersion
  - Expect modest funded ratio improvement over the next ~10 years, followed by more rapid growth thereafter
  - Tail cases demonstrate paths to full funding by 2027 (95^{th} percentile), or potential asset depletion around 2045 (5^{th} percentile)
- Contribution rates expected to increase to maximum amount under AAP before ultimately declining
  - Expect at least one AAP contribution increase by the 12/31/2025 actuarial valuation, two increases (maximum contribution rates) by the 12/31/2029 actuarial valuation
  - Tail cases demonstrate possibility of contribution decreases by 2026 (optimistic 5^{th} percentile), or two increases by 2025 (pessimistic 5^{th} percentile)

Next Steps:

- Determine other objectives or metrics of interest for study
- Assess impact of different asset allocations (see next section) on the above results

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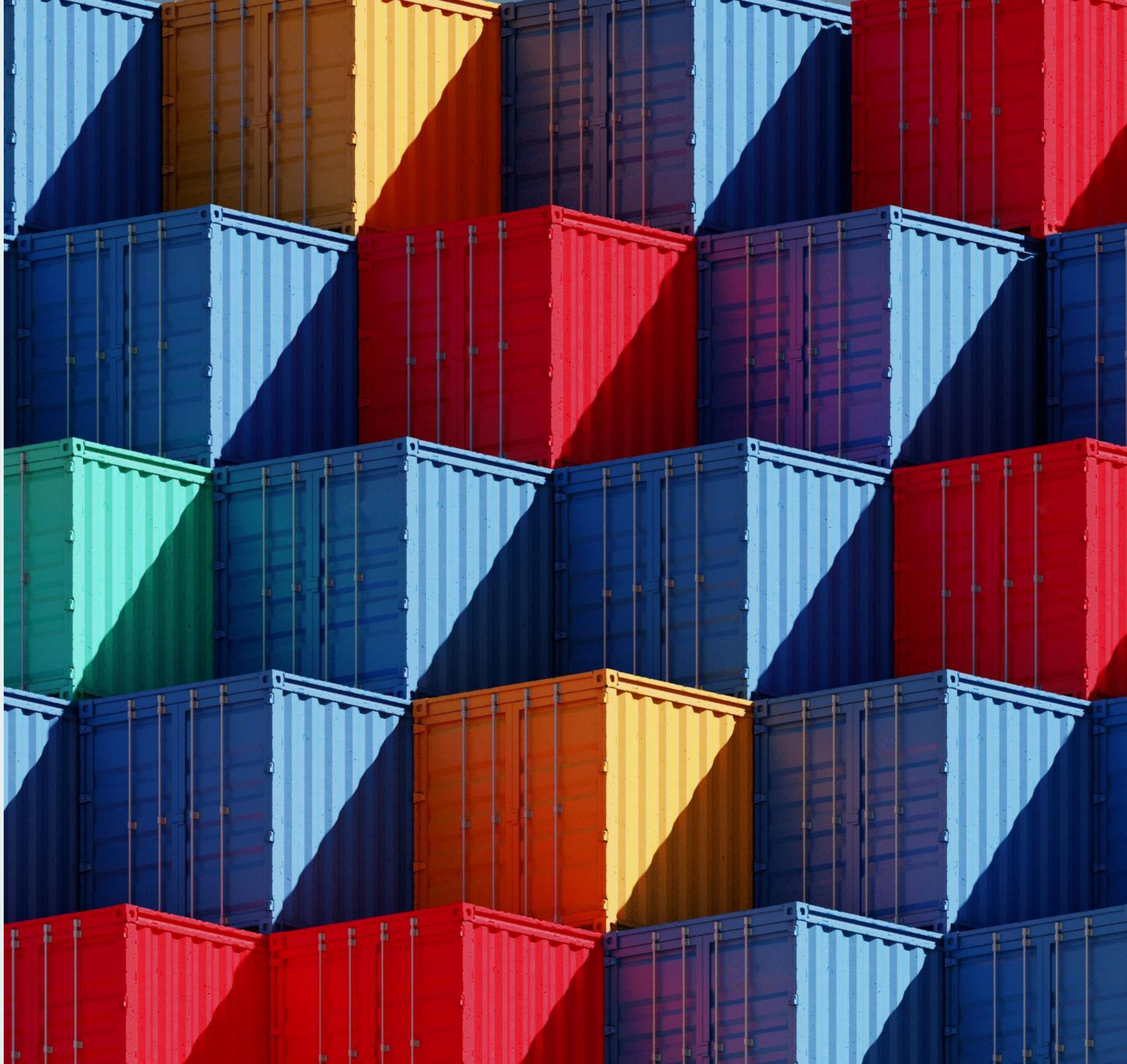
Additional Portfolios for Study



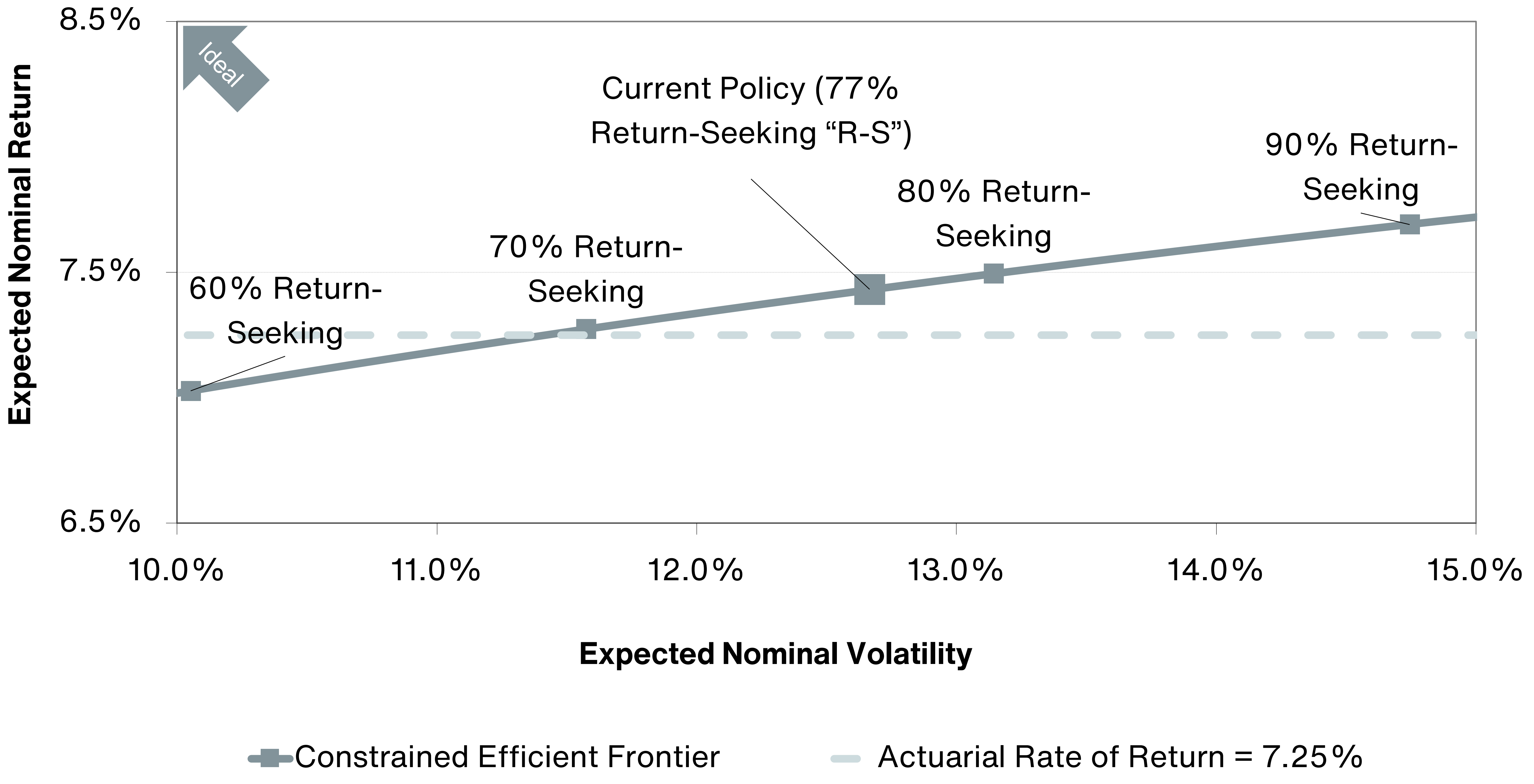
Key Portfolio Concepts for Asset-Liability Study

3 areas of focus: overall asset allocation, return-seeking portfolio, risk-reducing portfolio

Strategy Component	Initial Observations
1. Overall Asset Allocation (Return-Seeking vs. Risk-Reducing)	• Initial analysis suggests current asset allocation is in the reasonable return-seeking range given the actuarial return target and funding goal • Consider studying a range of asset allocations from 60% to 90% return-seeking • Asset allocation is the main driver of the projected risk/return profile
2. Return-Seeking Portfolio	• Initial analysis examined additional diversification including private equity, real assets, and return-seeking fixed income • Diversification may enhance the risk/return profile
3. Risk-Reducing Portfolio	• Initial analysis considered other risk-reducing assets • Ongoing evaluation of diversification and downside protection attributes

1: Overall Asset Allocation (% Return-Seeking vs. Risk-Reducing)

Study a range of asset allocations with different risk/return characteristics



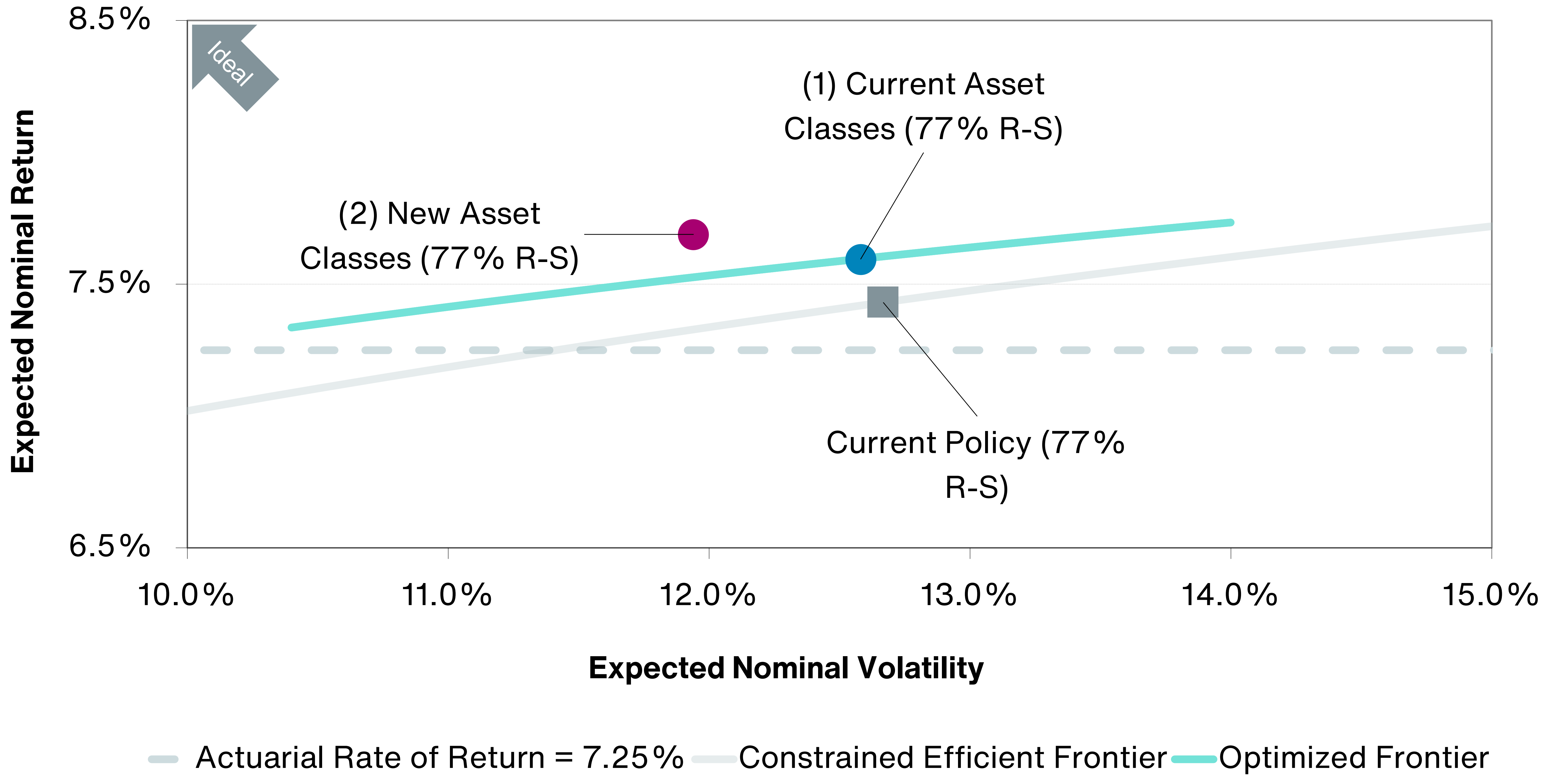
Key Observations:

- Initial analysis suggests current return-seeking allocation is in the reasonable range given the actuarial return target
- Consider studying a range of asset allocations from 60% to 90% return-seeking
- Asset allocation is the main driver of the projected risk/return profile

Expected returns are using AIUSA Q3 2023 30-Year Capital Market Assumptions (CMAs) as of 9/30/2023. CMAs contain projections about future returns on asset classes. Our CMA projections are designed to reflect the typical cost of implementing an investment program. Expected returns are calculated using weighted allocations of the underlying CMAs. Expected Returns are geometric (long-term compounded; rounded to the nearest decimal) assuming portfolio weights are rebalanced annually. Expected returns presented are models and do not represent the returns of an actual client account. Your actual returns may differ from model returns presented based on your plan's individual fees/expenses. Aon's advisory fees are described in Part 2A of Aon's Form ADV. Not a guarantee of future results. See appendix for capital market assumptions disclosure pages.
Real assets modeled as 50% infrastructure / 25% timber / 25% farmland
Opportunity modeled as 76% global equity / 24% core fixed income

2: Portfolio Structure (Selection of Return-Seeking & Risk-Reducing Assets)

Study diversification opportunities which may enhance risk/return



Key Observations:

- Current portfolio is well-diversified
- Initial analysis examined additional diversification strategies, which may enhance the risk/return profile
- Portfolio structures 1 and 2 consider private equity, real assets, and return-seeking fixed income (multi-asset credit, private direct lending) as potential diversifiers

Expected returns are using AIUSA Q3 2023 30-Year Capital Market Assumptions (CMAs) as of 9/30/2023. CMAs contain projections about future returns on asset classes. Our CMA projections are designed to reflect the typical cost of implementing an investment program. Expected returns are calculated using weighted allocations of the underlying CMAs. Expected Returns are geometric (long-term compounded; rounded to the nearest decimal) assuming portfolio weights are rebalanced annually. Expected returns presented are models and do not represent the returns of an actual client account. Your actual returns may differ from model returns presented based on your plan's individual fees/expenses. Aon's advisory fees are described in Part 2A of Aon's Form ADV. Not a guarantee of future results. See appendix for capital market assumptions disclosure pages.
Real assets modeled as 50% infrastructure / 25% timber / 25% farmland
Opportunity modeled as 76% global equity / 24% core fixed income

Additional Portfolios for Study
Observations and Next Steps

Observations

- Initial analysis suggests current asset allocation is in the reasonable range given the actuarial return target and funding goal
- Study a range of asset allocations with different risk/return characteristics
- Study diversification opportunities which may enhance risk/return

Next steps:

- Identify new asset classes, if any, to include in study
- Incorporate constraints reflecting, among other things, conviction in capital market assumptions (see next section)
- Analysis of additional portfolios, including impact on projected financials for March Board meeting

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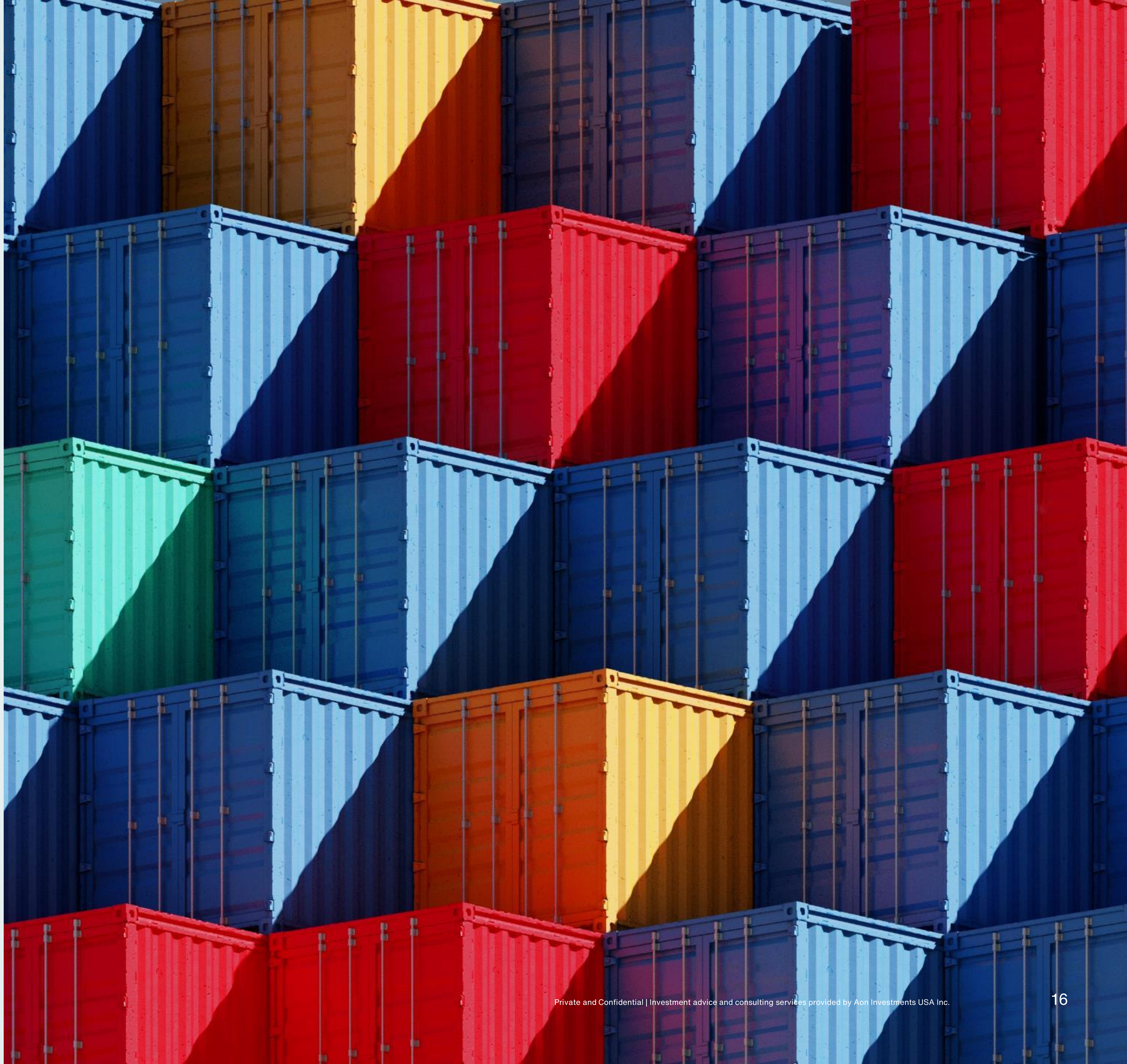
Capital Market Assumptions Follow-up



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Summary of Capital Market Assumptions ("CMAs")

As of September 30, 2023

		10-Year CMAs			30-Year CMAs		
		Expected Nominal Return[1]	Expected Nominal Volatility	Assumed Global Equity Beta	Expected Nominal Return[1]	Expected Nominal Volatility	Assumed Global Equity Beta
	Equity						
1	Large Cap U.S. Equity	6.7%	18.0%	0.96	7.0%	18.5%	0.97
2	Small Cap U.S. Equity	6.9%	24.0%	1.23	7.5%	24.8%	1.24
3	Global Equity IMI	6.9%	18.2%	1.00	7.4%	18.7%	1.00
4	International Equity (Developed)	6.7%	19.2%	0.94	7.0%	19.7%	0.94
5	Emerging Markets Equity	6.9%	22.0%	0.99	7.3%	22.5%	0.98
	Fixed Income						
6	Cash (Gov't)	4.6%	1.4%	0.01	4.2%	2.2%	0.01
7	Core Fixed Income	5.3%	5.0%	0.00	5.0%	5.2%	0.00
8	Long Duration Bonds – Credit	6.4%	9.7%	0.03	6.2%	10.1%	0.03
9	Long Duration Bonds – Gov't	5.5%	10.2%	-0.08	5.0%	9.9%	-0.07
10	Multi-Asset Credit	6.7%	8.5%	0.30	6.6%	8.7%	0.30
	Alternatives						
11	Hedge Funds - Low Beta[2]	5.6%	4.0%	0.09	5.2%	4.3%	0.09
12	Core Real Estate	5.6%	15.0%	0.30	5.5%	15.4%	0.30
13	Non-Core Real Estate	7.5%	25.0%	0.65	7.2%	25.5%	0.65
14	Private Equity	9.2%	20.0%	0.69	10.1%	20.5%	0.69
15	Infrastructure	7.2%	14.5%	0.28	7.1%	15.0%	0.28
16	Real Assets (PERA)[3]	6.7%	9.2%	0.15	6.6%	9.5%	0.15
17	Closed-End Real Assets	8.0%	15.7%	0.47	8.0%	16.2%	0.47
18	Farmland	5.5%	15.0%	0.01	5.5%	15.5%	0.01
19	Timber	4.8%	11.9%	0.01	4.8%	12.3%	0.01
20	Private Debt	8.2%	16.5%	0.33	7.7%	17.5%	0.34
21	Opportunistic (PERA)[4]	6.9%	13.9%	0.76	7.1%	14.3%	0.76
	Inflation						
22	Inflation	2.3%	1.7%		2.3%	1.8%	

[1] Expected returns are using Aon's 10/30-Year Capital Market Assumptions as of 9/30/2023. CMAs contain projections about future returns on asset classes. Our CMA projections are designed to reflect the typical cost of implementing an investment program. Expected returns are calculated using weighted allocations of the underlying CMAs. Expected Returns are geometric (long-term compounded; rounded to the nearest decimal) assuming portfolio weights are rebalanced annually. 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. Aon's advisory fees are described in Part 2A of Aon's Form ADV. Not a guarantee of future results.

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

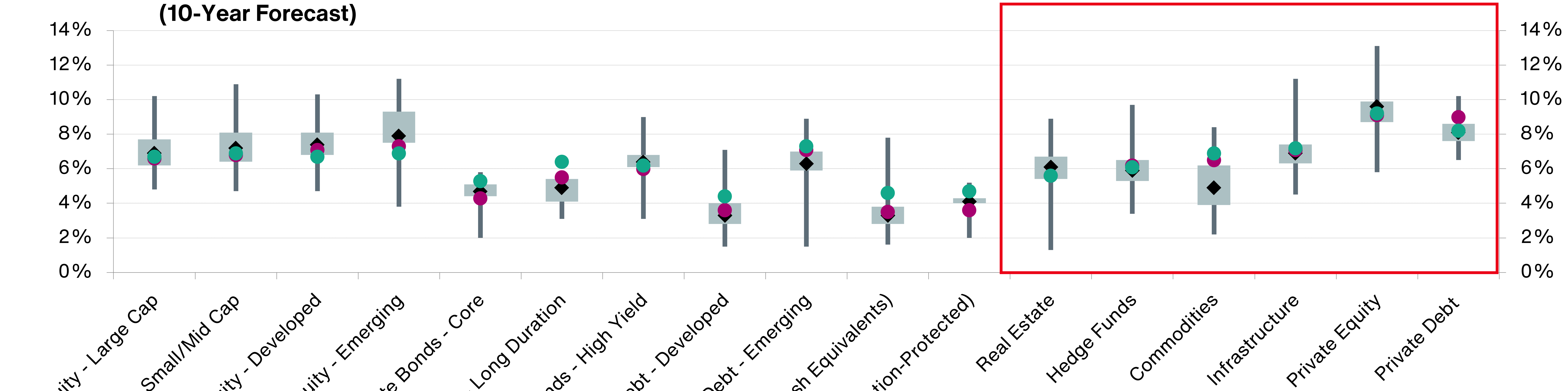
[3] Real assets modeled as 50% infrastructure / 25% timber / 25% farmland

[4] Opportunistic modeled as 76% global equity / 24% core fixed income

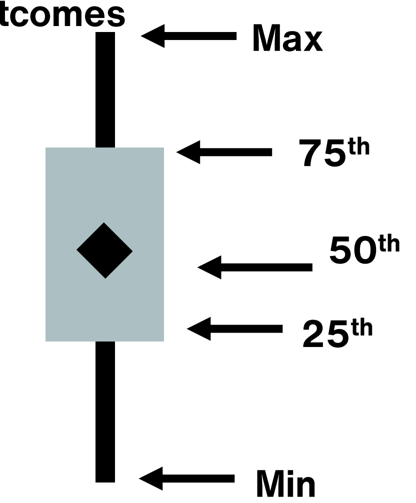
Capital Market Assumptions Peer Comparison

Aon generally in the middle 50 percent of Horizon survey respondents, including “harder to predict” asset classes; 9/30 CMAs have risen since 3/31 primarily due to rising yields

Expected Geometric Returns of 42 Investment Advisors (10-Year Forecast)



Legend: Distribution of Horizon Survey Outcomes

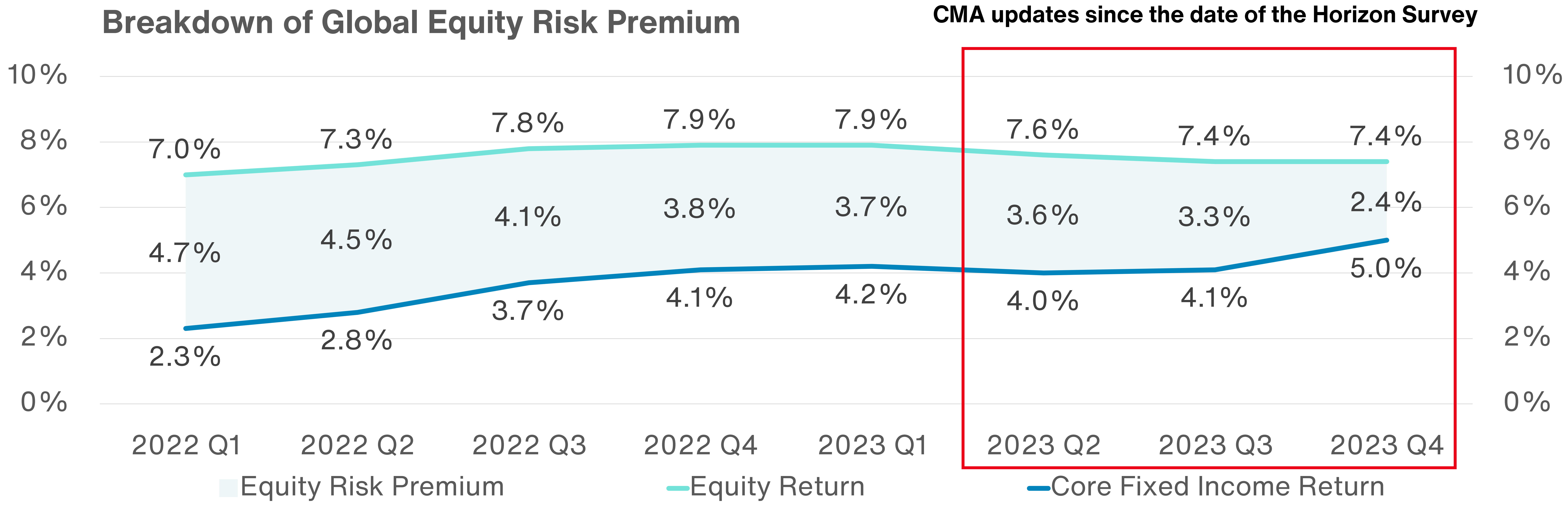


Source: Horizon Actuarial Solutions, LLC survey of 2023 capital market assumptions from 42 independent investment advisors
Aon Investments’ expected returns are annualized over 10-years as of 2Q 2023 (3/31/2023). CMAs contain projections about future returns on asset classes. Our CMA projections are designed to reflect the typical cost of implementing an investment program. Not a guarantee of future results. Additional information regarding our capital market assumptions can be made available upon request.

Capital Market Assumptions Recent Changes

Equity risk premium[1] has decreased due to higher interest rates, fixed income returns

Below is a quarter-over-quarter historical look at the breakdown of the global equity risk premium[1] (defined as global public equity less core fixed income) using Aon's 30-year CMAs



[1] Equity Risk Premium is defined as the excess return earned over bonds that compensates investors for taking on higher risk

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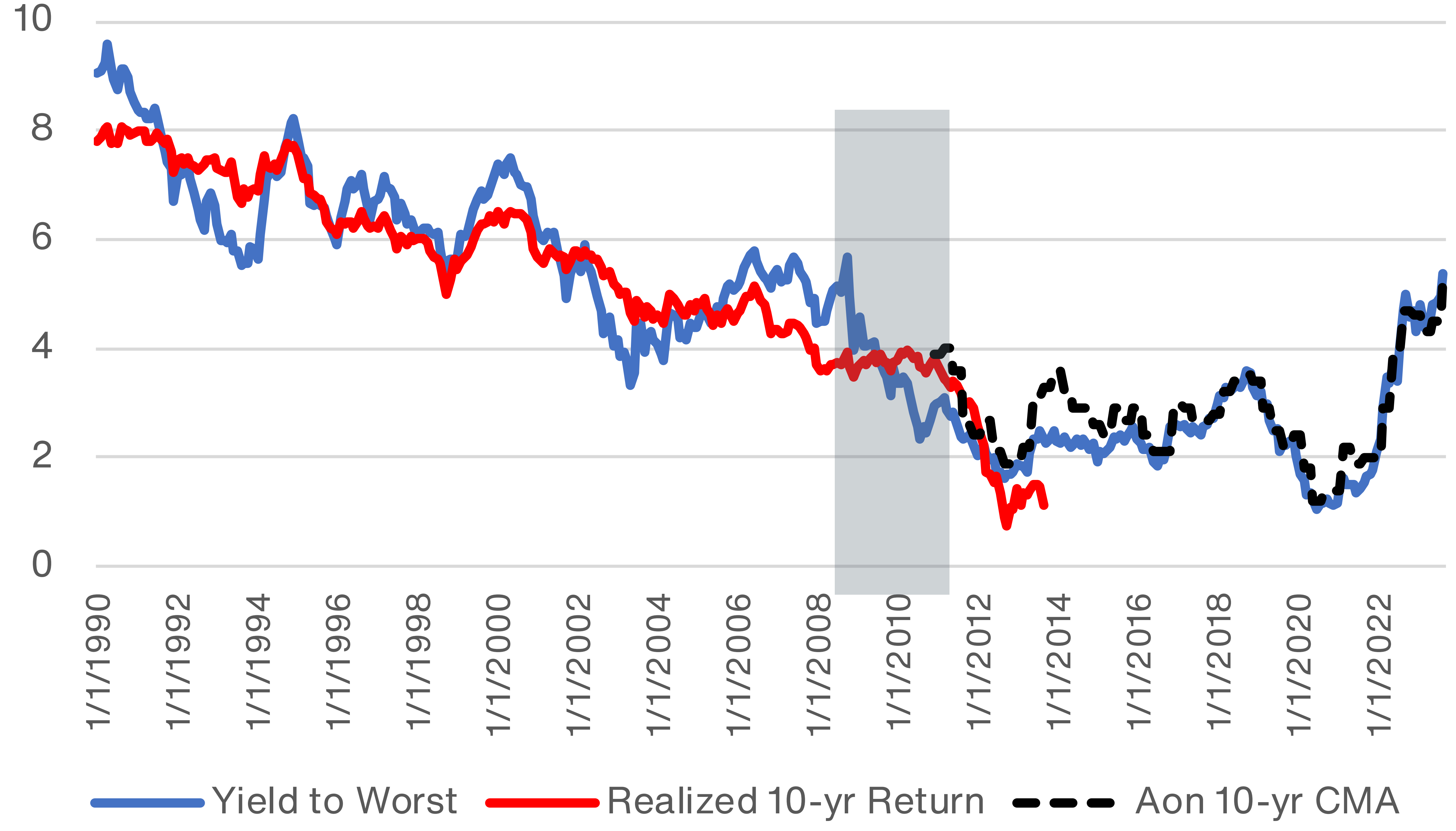
Capital Market Assumptions Back-Testing

10-year expectations vs. realized returns for U.S. Core Fixed Income[1]

Yields are the primary driver of realized return and capital market assumptions

Historical Yield to Worst vs. 10 Year Realized Return vs. Aon Median Return Expectation for U.S. Core Fixed Income



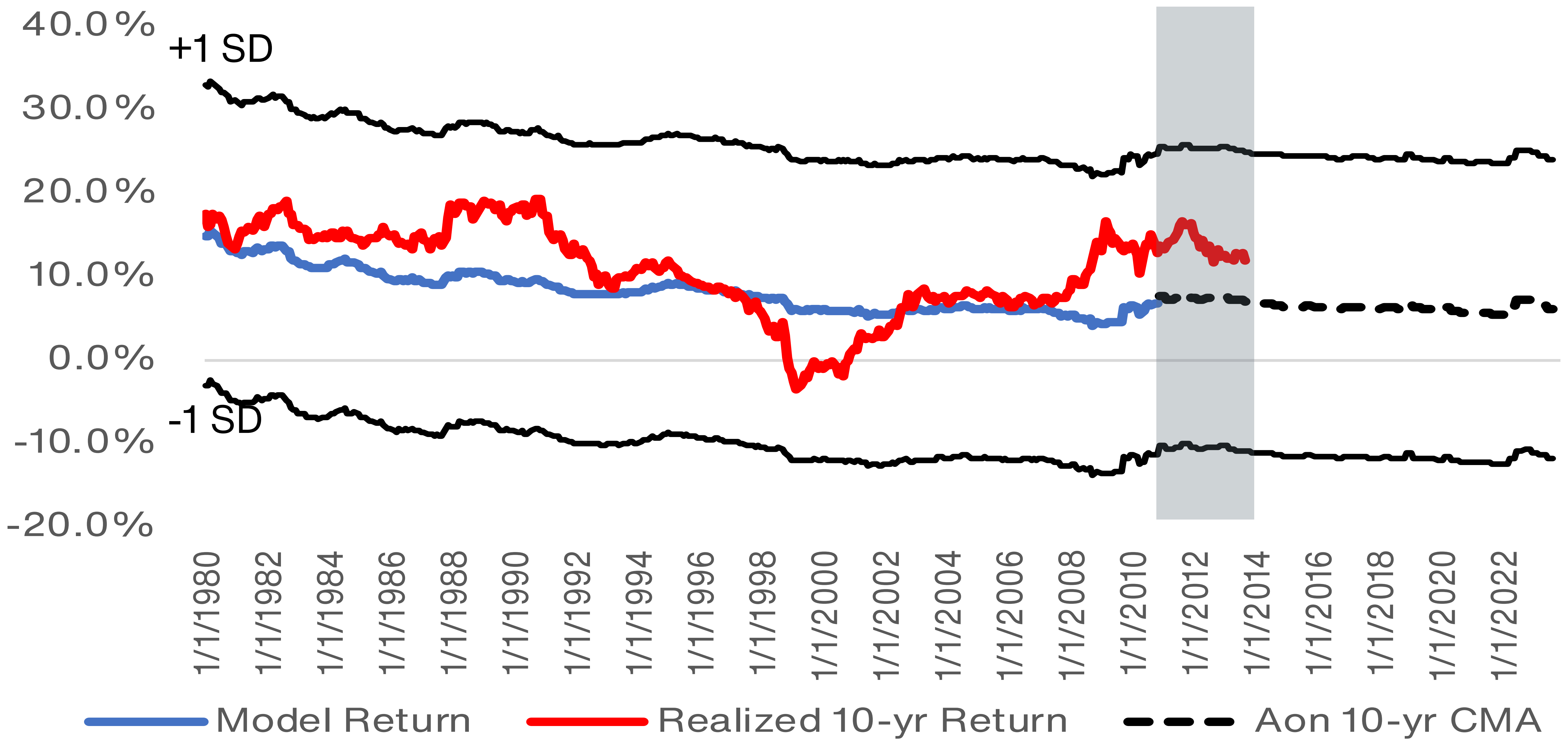
1Bloomberg Barclays Aggregate bond index yield-to-worst compared to subsequent 10-year total return (realized 10-yr return).

Capital Market Assumptions Back-Testing

10-year expectations vs. realized for U.S. Large Cap Equity[1]

Applying Aon CMA methodology to historical periods shows periods of over- and under-performance, but well within +/- 1 standard deviation estimates

Historical 10 Year Realized Return vs. Aon Median Return Expectation (Extrapolated) for U.S. Large Cap Equity



1E/Ps based on 12-month trailing S&P 500 P/E ratios. Inflation is represented by actual annualized 10-yr CPI. 10-yr annualized real GDP is growth sourced from St. Louis FED data.

Capital Market Assumptions for Private Asset Classes

Use “median manager” assumptions and qualitative assessments in areas where manager selection a key factor

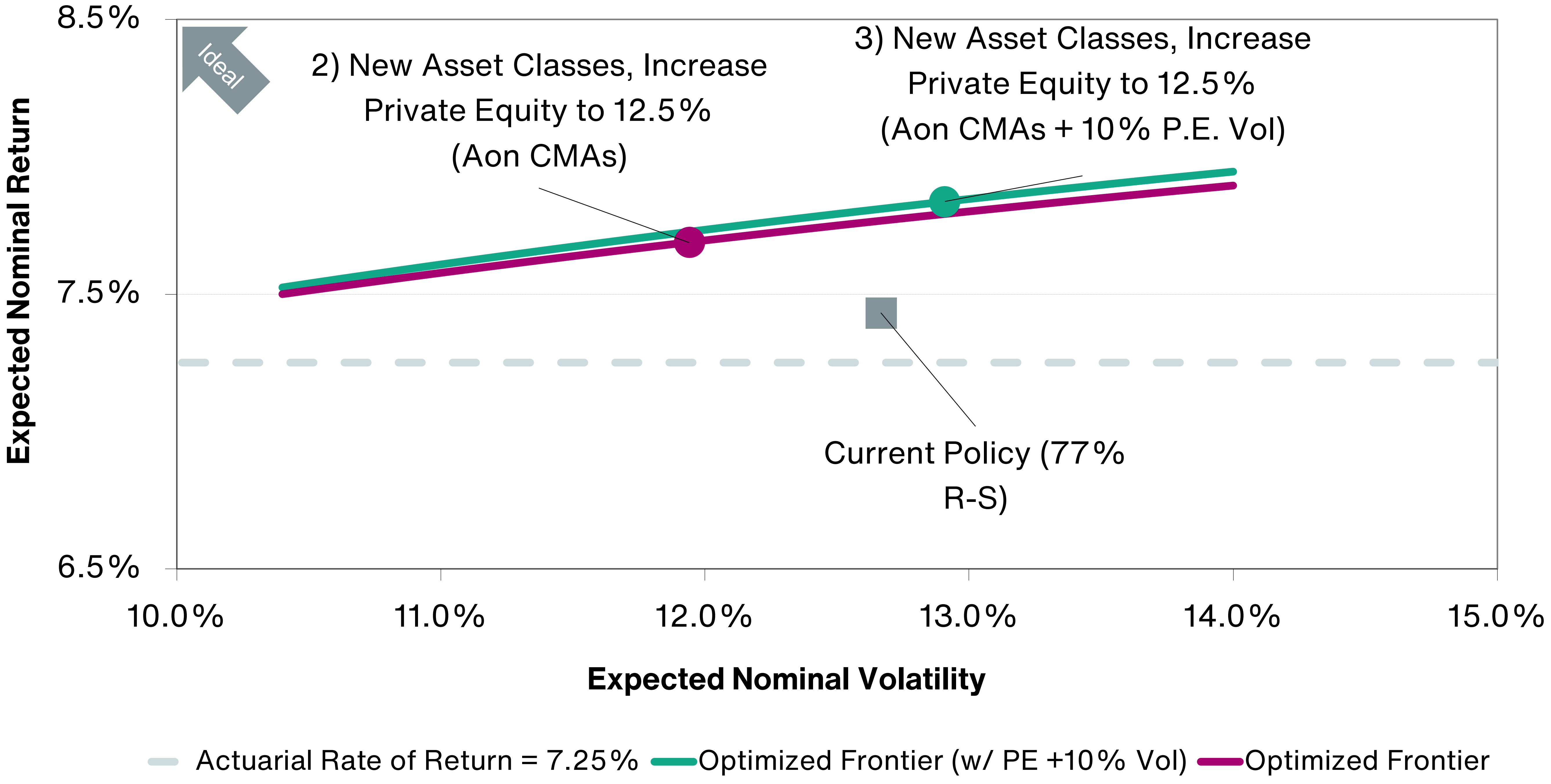
Difficulty/complexity associated with manager selection and corresponding sensitivity of results are two major reasons investors may limit their private market exposure, despite having sufficient liquidity and time horizon for investment. Other reasons include resource constraints, fee sensitivity, conviction in return potential, and desire/need for diversification.

We use quantitative and qualitative approaches to mitigate these effects. Examples include:

- We collect **input from PERA’s Investment Teams** prior to adding to existing or new asset classes.
- We develop our private market CMAs assumptions with risk and return expectations that we believe are achievable using **median manager** results (net of fees)
- We incorporate **modeling constraints** on asset classes that reasonably reflect client preferences and circumstances.
- Optionally, we can use custom assumptions and/or conduct **sensitivity analysis** on key assumptions (see following page)

Capital Market Assumptions for Private Asset Classes

Use sensitivity analysis on key assumptions to better understand model behavior



Key Observations:

- Aon can use custom assumptions and/or conduct sensitivity analysis on key assumptions, like private equity volatility, to better understand how assumptions influence model results
- In the initial analysis shown, model results demonstrate a similar preference for private equity using both Aon CMAs (portfolio 2) and modified CMAs with a 10-percentage point higher private equity volatility assumption (portfolio 3)

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Capital Market Assumptions Follow-up

Observations and Next Steps

Observations

- Aon has a robust capital market assumption setting process that includes back-testing and peer comparisons across many asset classes
- Additional qualitative and quantitative assessments can be incorporated into portfolio analysis
    - For example, applying constraints on lower conviction asset classes and/or performing sensitivity analysis on asset class assumptions

Next steps:

- Finalize capital market assumptions for use in study
- Incorporate constraints and sensitivity analysis in study of additional portfolios

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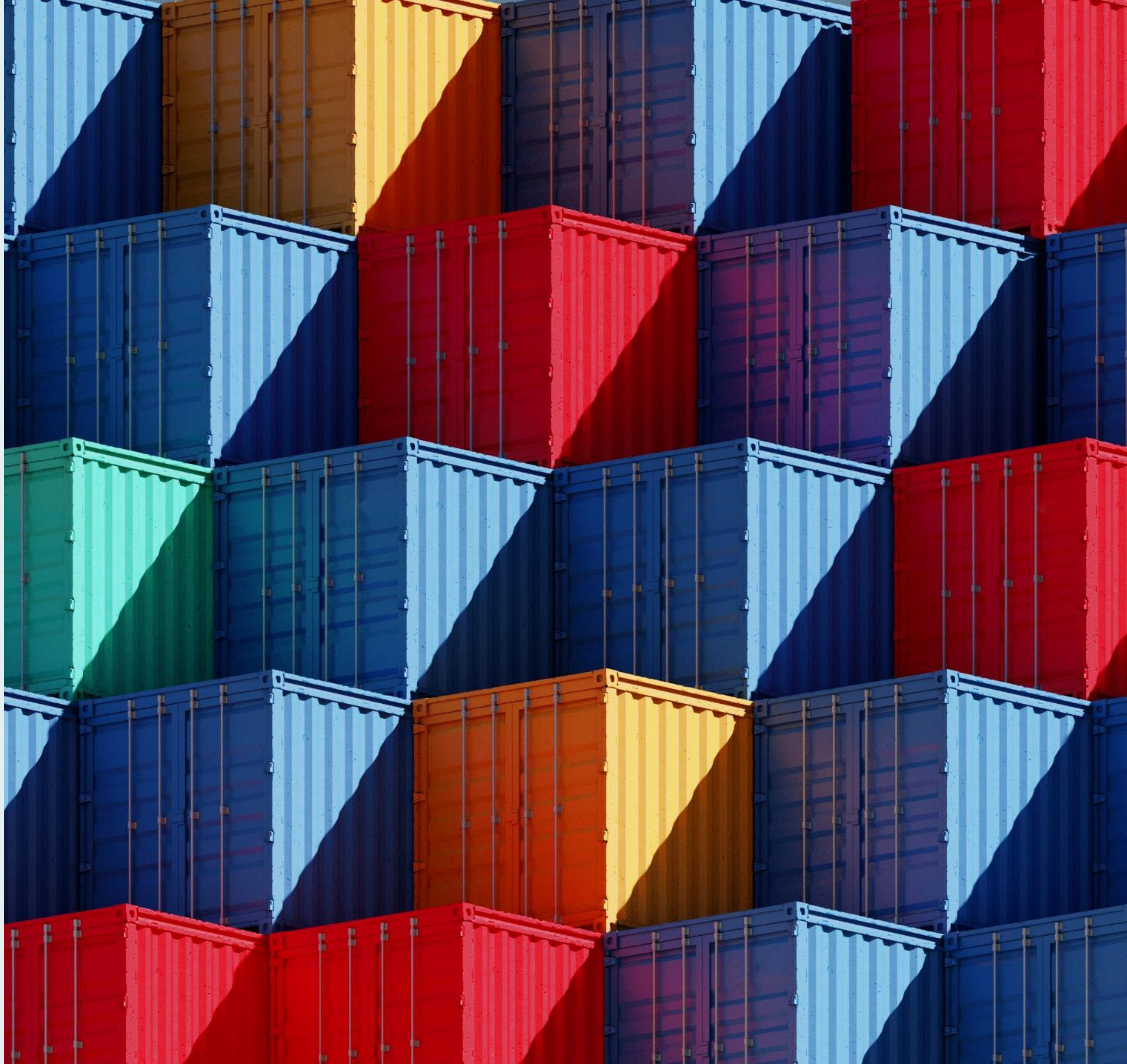
Next Steps



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Next Steps

- Additional meeting(s) with PERA investment team to validate capital market assumptions and portfolio ideas
- Analysis of additional portfolios, including impact on projected financials for March Board meeting
- Finalize analysis and conclusions for June Board meeting

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Appendix

- Additional Details on Initial Projection Results
- Actuarial Assumptions and Methods
- Capital Market Assumptions
- About this Material

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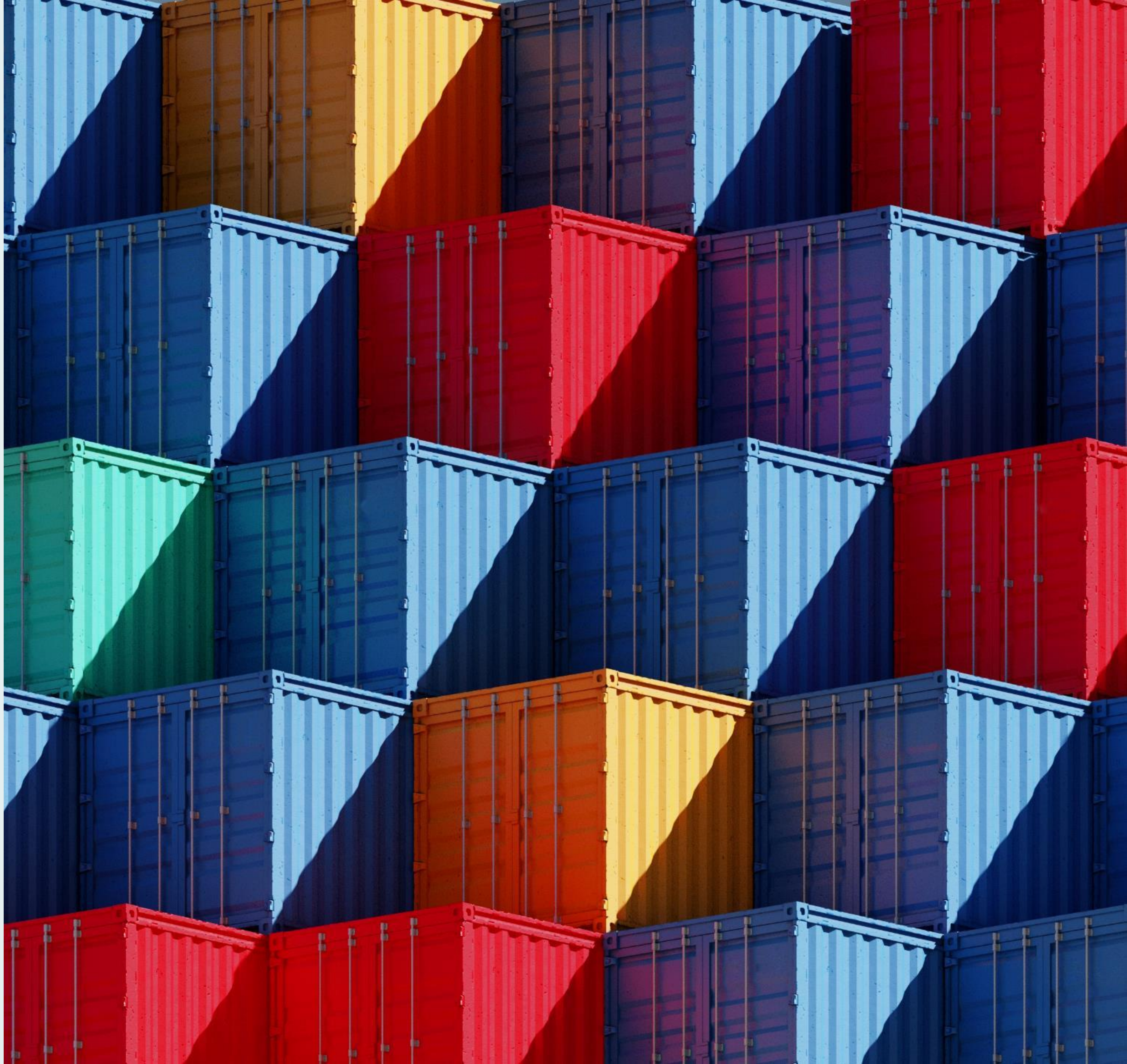


Additional Details on Initial Projection Results

Initial Asset-Liability Projection Analysis

Likelihood of triggering AAP using various methods

Initial Results (as of fiscal year end 12/31):

1) Segal Results using "Signal Light" Method	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Decrease Contributions	0%	0%	3%	11%	17%	20%	23%	26%	29%	31%
No Change	98%	64%	37%	31%	26%	23%	21%	17%	15%	13%
Increase Contributions	2%	36%	60%	58%	57%	56%	56%	56%	57%	57%
2) Aon Results using "Signal Light" Method	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Decrease Contributions	0%	2%	6%	16%	22%	25%	28%	30%	31%	33%
No Change	96%	63%	38%	31%	26%	22%	19%	17%	16%	13%
Increase Contributions	4%	35%	56%	53%	53%	53%	53%	53%	53%	54%
3) Aon Results using Full Stochastic Method	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Decrease Contributions	0%	2%	6%	16%	20%	20%	17%	15%	13%	12%
No Change	96%	63%	43%	69%	73%	73%	77%	80%	81%	83%
Increase Contributions	4%	35%	51%	15%	7%	7%	6%	6%	6%	5%
4) Aon Results using Full Stochastic Method and YTD experience	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Decrease Contributions	0%	0%	1%	9%	18%	23%	20%	16%	15%	13%
No Change	100%	73%	41%	71%	76%	71%	74%	79%	80%	81%
Increase Contributions	0%	27%	58%	20%	6%	6%	6%	5%	5%	5%

Agreement to use Method #4

Aon model produces similar results to Segal using the "Signal Light" method

- Minor differences due to different models and assumptions used

Proposed "Full Stochastic" method includes two main enhancements

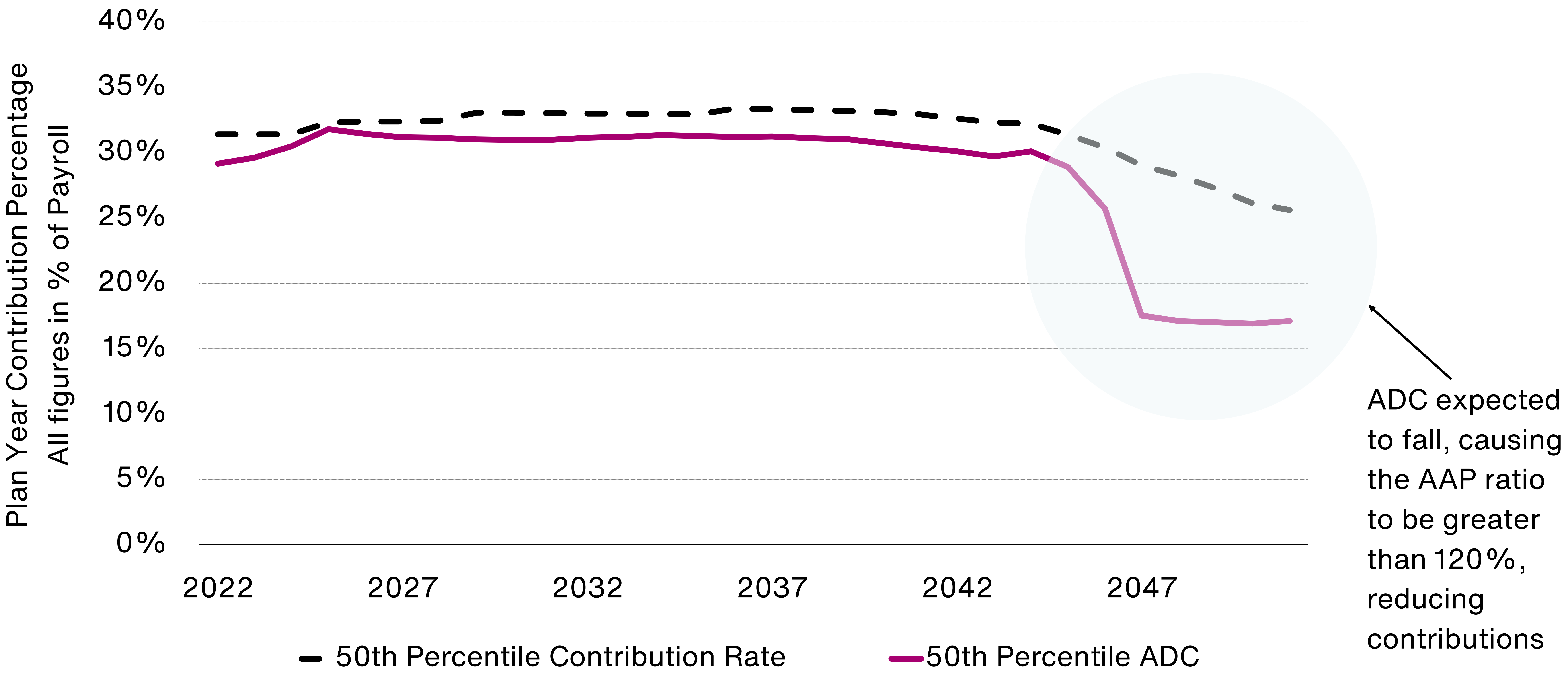
1- Path dependence- likelihood of triggering AAP in a given year reflects the impact of AAP adjustments triggered in all previous years, if any

2- Range boundaries- "No Change" in AAP if contributions are already at maximum or minimum levels

Projections assume a constant 7.25% discount rate for pension liabilities for all investment policies studied. Projections in this material include estimated expenses paid from plan assets, estimated to be $44.1 million for fiscal year ending 12/31/2023, which is assumed to be inclusive of investment management fees. These are increased with inflation for projection purposes. Actual fees and expenses may differ from those presented. Percentages may not sum to 100% due to rounding.

Initial Asset-Liability Projection Analysis

Median contribution rate vs. actuarially-determined contribution ("ADC")



Key Observations

- Median (50th percentile) case ADC notably decreases in later years due to the expiration of the 12/31/2017 legacy UAAL amortization base which is being amortized over 30 years
- The difference between the PERA contribution rate and ADC in later years increases the likelihood of triggering the AAP to decrease contributions

Projections assume a constant 7.25% discount rate for pension liabilities for all investment policies studied and reflect actual investment returns through September 30, 2023. Projections in this material include estimated expenses paid from plan assets, estimated to be $44.1 million for fiscal year ending 12/31/2023, which is assumed to be inclusive of investment management fees. These are increased with inflation for projection purposes. Actual fees and expenses may differ from those presented.

Actuarial Assumptions and Methods

Actuarial Assumptions and Methods

Data used & actuarial assumptions

Data

Actuarial projections for the full asset-liability study reflected open group projections from the plan actuary (Segal) as of December 31, 2022. The information was supplied for all five (5) plans with sensitivity for realized inflation (intended to proxy the annual increase impact). These plan figures were combined to study the aggregate division trust funds for purposes of this study.

Actuarial assumptions:

- Valuation Rate of Interest = 7.25%
- Inflation = 2.30%
- Payroll Growth = 3.00%
- Actuarial Value of Assets: determined by recognizing differences between actual and expected investment income over a closed four-year period with no corridor
- Administrative Expenses: Assumed $44.1 million payable from the trust for 2023 consistent with the provided actuarial projections
    - Assumed annual growth consistent with inflation
- Annual Increase rate = 1.00%
- All other assumptions as documented in the Actuarial Valuation Report as of December 31, 2022 unless noted otherwise

Source: [12/31/2022 Actuarial Valuation]

Actuarial Assumptions and Methods

Employer/state contributions

Employer Contributions:

Initial employer contributions were assumed to be 18.53% of payroll. This is based on the following components detailed in the Actuarial Valuation Report as of 12/31/2022, weighted by expected payroll as provided by the plan actuary. Rates are projected to remain level unless otherwise stated.

Division	Projected Payroll 2023 ($ million)	Basic Rate[1]	Annual Increase Reserve	Amortization Equalization Disbursement (AED)	Supplemental Amortization Equalization Disbursement (SAED)	Pension Certificates of Participation	Defined Contribution Supplement	Total
State	3,340	10.52%[2]	-0.69%	5.00%	5.00%	0.00%	0.21%	20.04%
School	5,973	10.38%	-0.61%	4.50%	5.50%	0.00%	0.00%	19.77%
Local Government	800	9.99%[2]	-0.72%	2.20%	1.50%	0.00%	0.08%	13.05%
Judicial	59	13.89%	-0.63%	5.00%	5.00%	0.00%	0.00%	23.26%
Denver Public Schools	861	10.38%	-0.73%	4.50%	5.50%	-10.77%	0.00%	8.88%
Aggregate	**11,033**						**Weighted Average:**	**18.53%**

[1] Basic rate stated reflects current 1.00% increase for AAP and 1.02% reduction for the Health Care Trust Fund Contribution

[2] State and Local Government basic rates reflect blended rate of 13.08% for State Trooper Members, 10.38% for all other State division members, and 9.98% for all other Local Government division members

Direct Distribution:

Assumed to be $35 million as of 7/1/2023 and reverting to $225 million as of 7/1/2024 and beyond (subject to Automatic Adjustment Provisions)

Source: 12/31/2022 Actuarial Valuation

Actuarial Assumptions and Methods

Member/employee contributions

Member / Employee Contributions:

Initial member contributions were assumed to be 10.89% of payroll. This is based on the following member contribution rates detailed in the Actuarial Valuation Report as of 12/31/2022, weighted by expected payroll as provided by the plan actuary. Rates are projected to remain level unless otherwise stated.

Division	Projected Payroll 2023 ($ million)	Member / Employee Contribution Rate[1]
State	3,340	11.10%[2]
School	5,973	11.00%
Local Government	800	9.01%[3]
Judicial	59	11.00%
Denver Public Schools	861	11.00%
Aggregate / Weighted Average by Payroll	**11,033**	**10.89%**

[1] Member rate stated reflects current 1.00% increase for AAP

[2] State member / employee rate reflects blended rate of 13.00% for State Trooper Members and 11.00% for all others

[3] Local Government member / employee rate reflects blended rate of 13.00% for State Trooper Members and 9.00% for all others

Source: 12/31/2022 Actuarial Valuation

Actuarial Assumptions and Methods

Automatic adjustment provision (AAP)

SB 18-200 includes a mechanism for an automatic adjustment to stay on track for full funding of the pension plans

The Automatic Adjustment Provision (AAP) impacts employer contributions, member contributions, the annual increase (annual cost-of-living adjustment), and the direct distribution received from the state. The AAP of SB 18-200 was designed using the concept of comparing one blended statutory rate or “Blended Total Contribution Amount” to one “Blended Total Required Contribution” across all five division trust funds

Blended Total Contribution Amount	÷	Blended Total Required Contribution	=	AAP Resulting Ratio
+ Employer contribution rates + Member contribution rate + Direct distribution as a rate of pay **= Blended Total Contribution Amount**		+ Actuarially determined contribution rate[1] + Member contribution rate **= Blended Total Required Contribution**		

AAP Resulting Ratio	Impact
<98%	Equitable adjustments applied (e.g., increase contributions, lower AI)
98% to 119%	No adjustment
≥120%	Equitable adjustments applied (e.g., decrease contributions, increase AI)

The Actuarial Valuation Report as of December 31, 2022 determines member contribution, employer contribution, and actuarial determined contribution rates by division and calculates plan totals based on the weighted average of unfunded liability by each division. For purposes of the stochastic modeling, Aon’s asset-liability study considers the total pension system in aggregate for determining these rates.

[1]Actuarially determined contribution rate determined as the sum of the Employer’s portion of Normal Cost plus the Unfunded Accrued Actuarial Liability amortized over layered, closed 30-year, level percent periods

Source: 12/31/2022 Actuarial Valuation

Actuarial Assumptions and Methods

Automatic adjustment provision (AAP)

When an adjustment is activated under the Automatic Adjustment Provision (AAP), Aon has assumed that each lever will move in its maximum annual amount subject to the restricted minimum and maximum amounts:

- Employer and Member Contribution Rates – Annual adjustments cannot exceed 50 basis points
- Actuarial Increase (Cost of Living Adjustment) – Annual adjustment cannot exceed 25 basis points
- Direct Distribution – Annual adjustments of $20 million

Aon has assumed the levers utilized under the AAP have the following minimum and maximum amounts:

- Employer and Member / Employee Contribution Rates
  - Rates cannot be less than the statutory contribution rates based on SB 18-200
  - Rates cannot exceed the statutory contribution rates plus 2% based on SB 18-200

- Annual Increase (Cost of Living Adjustment)
  - Cannot fall below a 0.50% annual increase cap minimum
  - Cannot exceed a 2.00% annual increase cap maximum

- Direct Distribution
  - Can fall to a minimum of $0
  - Cannot exceed $225 million per year

Actuarial Assumptions and Methods

Automatic adjustment provision (AAP) – levers available

PERA's current positioning on the four levers is shown below

- The right-side of the exhibit represents the limit on each lever to improve the funded ratio

Member Contributions
(cumulative increase since 2018)

Employer Contributions
(cumulative increase since 2018)

Annual Increase to Retirees

Direct Distribution from State
(in $ Millions)

The AAP was triggered for the 2020 and 2022 plan years resulting in:

- Cumulative 1% increase to member and employer contributions
- Cumulative 0.5% reduction in the annual increase to retirees (from 1.5% to 1.0%)
- No change to the direct distribution

Actuarial Assumptions and Methods

Automatic adjustment provision (AAP) – minimum and maximum employer rates

Employer Contributions Minimum (Basic Rate):

Assumed to be an aggregate rate of 9.41% of payroll. This is determined based on the statutory rates stated in SB 18-200 weighted by expected payroll as provided by the plan actuary unless otherwise stated:

Division	Projected Payroll 2023 ($ million)	Current Basic Rate[1,2]	Statutory Basic Rate under SB 18-200[2]
State	3,340	10.52%[3]	9.52%[3]
School	5,973	10.38%	9.38%
Local Government	800	9.99%[3]	8.99%[3]
Judicial	59	13.89%	12.89%
Denver Public Schools	861	10.38%	9.38%
Aggregate / Weighted Average by Payroll	**11,033**	**10.41%**	**9.41%**

Employer Contributions Maximum (Basic Rate):

Assumed to be an aggregate rate of 11.41% of payroll. This is determined based on the statutory rates stated in SB 18-200 plus 2% weighted by expected payroll as provided by the plan actuary unless otherwise stated:

Division	Projected Payroll 2023 ($ million)	Current Basic Rate[1,2]	Statutory Basic Rate under SB 18-200 Plus 2%[2]
State	3,340	10.52%[3]	11.52%[3]
School	5,973	10.38%	11.38%
Local Government	800	9.99%[3]	10.99%[3]
Judicial	59	13.89%	14.89%
Denver Public Schools	861	10.38%	11.38%
Aggregate / Weighted Average by Payroll	**11,033**	**10.41%**	**11.41%**

[1] Current basic rate stated reflects 1.00% increase associated with the AAP

[2] Basic rates reflect a 1.02% reduction for the Health Care Trust Fund Contribution

[3] State and Local Government basic rates reflect blended rates of 12.08% (Statutory) / 13.08% (Current) / 14.08% (Statutory +2%) for State Trooper Members, 9.38% / 10.38% / 11.38% for all others in the State division, and 8.98% / 9.98% / 10.98% for all others in the Local Government division

Source: SB 18-200, 12/31/2022 Actuarial Valuation

Actuarial Assumptions and Methods

Automatic adjustment provision (AAP) – minimum and maximum member rates

Member / Employee Contributions Minimum (Basic Rate):

Assumed to be an aggregate rate of 9.89% of payroll. This is determined based on the statutory rates stated in SB 18-200 weighted by expected payroll as provided by the plan actuary unless otherwise stated:

Division	Projected Payroll 2023 ($ million)	Current Basic Rate[1]	Statutory Basic Rate under SB 18-200
State	3,340	11.10%[2]	10.10%[2]
School	5,973	11.00%	10.00%
Local Government	800	9.01%[2,3]	8.01%[2,3]
Judicial	59	11.00%	10.00%
Denver Public Schools	861	11.00%	10.00%
Aggregate / Weighted Average by Payroll	**11,033**	**10.89%**	**9.89%**

Member / Employee Contributions Maximum (Basic Rate):

Assumed to be an aggregate rate of 11.89% of payroll. This is determined based on the statutory rates stated in SB 18-200 plus 2% weighted by expected payroll as provided by the plan actuary unless otherwise stated:

Division	Projected Payroll 2023 ($ million)	Current Basic Rate[1]	Statutory Basic Rate under SB 18-200 Plus 2%
State	3,340	11.10%[2]	12.10%[2]
School	5,973	11.00%	12.00%
Local Government	800	9.01%[2,3]	10.01%[2,3]
Judicial	59	11.00%	12.00%
Denver Public Schools	861	11.00%	12.00%
Aggregate / Weighted Average by Payroll	**11,033**	**10.89%**	**11.89%**

[1] Current basic rate stated reflects 1.00% increase associated with the AAP

[2] State and Local Government basic rates reflect blended rate of 12.00% (Statutory) / 13.00% (Current) / 14.00% (Statutory +2%) for State Trooper Members, 10.00% / 11.00% / 12.00% for all others in the State division, and 8.00% / 9.00% / 10.00% for all others in the Local Government division

[3] Local Government rates based on HB 19-1217

Sources: SB 18-200, HB 19-1217, 12/31/2022 Actuarial Valuation

Actuarial Assumptions and Methods

Automatic adjustment provision (AAP) – annual increase (cost of living adjustment)

The initial Annual Increase (AI) is assumed to be 1.00% per year based on the Actuarial Valuation Report as of December 31, 2022.

The plan actuary provided projected actuarial accrued liability, normal cost, and annual benefit payments under three scenarios: (1) baseline assumptions consistent with the 12/31/2022 actuarial valuation, (2) +100 basis points realized inflation relative to baseline, and (3) -100 basis points realized inflation relative to baseline.

The projection tracks the AI rate each year and adjusts based on the Automatic Adjustment Provision. The cumulative AI trial is determined and compared to the cumulative rates assumed under the three scenarios of actuarial data. This comparison determines the interpolation point in setting the resulting actuarial accrued liability, normal cost, and annual benefit payments.

An illustrative example of this method is as follows:

Illustrative Example	Projection Trial Example AI	Cumulative Projection Trial Example AI	Actuarial Data Cumulative AI (Baseline Assumptions)	Actuarial Data Cumulative AI (+1% Sensitivity Assumptions)	Illustrative Liability Data (Baseline Assumptions)	Illustrative Liability Data (+1% Sensitivity Assumptions)	Resulting Liability
Year 1	1.0%	1.0%	1.0%	2.0%	$100	$120	$100
Year 2	2.0%	3.0%	2.0%	4.0%	$110	$140	$125

Annual increases of 1.0% and 2.0% total a 3.0% cumulative increase over two years

The 3.0% cumulative increase falls between the 2.0% and 4.0% cumulative increases under the actuarial projection data scenarios

The corresponding point between the liability data scenarios results in $125 under the illustrative example conditions shown here

Actuarial Assumptions and Methods

AED and SAED

Per C.R.S. Sections 24-51-411(8) and 24-51-411(9), the Amortization Equalization Disbursement (AED) and Supplemental Amortization Equalization Disbursement (SAED) components of employer contributions are adjusted based on the year-end actuarial funded ratio within a particular division.

If a division trust fund's actuarial funded ratio:

- Reaches 103%, a 50 basis point decrease in both the AED and SAED is mandated
- Falls below 90%, a 50 basis point increase in both the AED and SAED is mandated
- For Local Government and Judicial divisions, if the actuarial funded ratio reaches 90% and subsequently falls below 90%, an increase in AED and SAED is mandated for these divisions, subject to a limit of 5.00%

For purposes of the stochastic modeling, Aon's asset-liability study looks at the total aggregate pension system for the year-end actuarial funded ratio for the AED and SAED determination. Aggregate plan rates were assumed weighted by projected payroll as follows:

Division	**Projected Payroll 2023 ($ million)**		**Current 2023 AED Rates**	**Current 2023 SAED Rates**
State	3,340		5.00%	5.00%
School	5,973		4.50%	5.50%
Local Government	800		2.20%	1.50%
Judicial	59		5.00%	5.00%
Denver Public Schools	861		4.50%	5.50%
Aggregate	**11,033**	**Weighted Average:**	**4.49%**	**5.06%**

The AED and SAED were assumed to increase no higher than 2023 levels and no lower than 0% in aggregate.

Source: C.R.S Section 24-51-411, 12/31/2022 Actuarial Valuation

Actuarial Assumptions and Methods

Pension certificates of participation (PCOP)

Employer contribution rates for the Denver Public Schools Division reflect offsets for costs of certain Pension Certificates of Participation (PCOP). This offset was assumed to be 10.77% of Denver Public Schools payroll as of the 12/31/2022 valuation. This was assumed to be a rate of 0.84% of aggregate payroll based on the weighted expected payroll as provided by the plan actuary.

Division	Projected Payroll 2023 ($ million)		Pension Certificates of Participation Credit as Percent of Payroll (12/31/2022)
State	3,340		0.00%
School	5,973		0.00%
Local Government	800		0.00%
Judicial	59		0.00%
Denver Public Schools	861		-10.77%
Aggregate	**11,033**	**Weighted Average:**	**-0.84%**

The PCOP offset to trust contributions is expected to decrease annually and eventually cease. Our projections assume the PCOP offset moves toward zero by 0.025% of aggregate payroll annually and reduces to zero for fiscal year 2038 based on baseline projections as provided by the plan actuary. Actual PCOP experience may vary from these assumed rates.

Source: 12/31/2022 Actuarial Valuation

Actuarial Assumptions and Methods

Other employer contribution rate components

The stochastic modeling assumes aggregate plan rates for the Annual Increase Reserve and Defined Contribution Supplement components of the employer contribution rate. While the annual increase reserve is expected to grow to an offset value of 1.00% over time as defined contribution participation grows, these component rates were assumed to remain level over the projection period for purposes of our asset-liability study projection modeling. The aggregate rates were developed by weighted expected payroll as provided by the plan actuary as follows:

Division	Projected Payroll 2023 ($ million)		Annual Increase Reserve	Defined Contribution Supplement
State	3,340		-0.69%	0.21%
School	5,973		-0.61%	0.00%
Local Government	800		-0.72%	0.08%
Judicial	59		-0.63%	0.00%
Denver Public Schools	861		-0.73%	0.00%
Aggregate	**11,033**	**Weighted Average:**	**-0.65%**	**0.07%**

Source: 12/31/2022 Actuarial Valuation

Capital Market Assumptions

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

Summary of Capital Market Assumptions

As of September 30, 2023

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Large Cap U.S. Equity	**1.00**	0.93	0.98	0.79	0.73	0.09	0.00	0.06	-0.13	0.61	0.40	0.35	0.46	0.62	0.35	0.29	0.52	0.01	0.01	0.34	0.97	0.09
2	Small Cap U.S. Equity	0.93	**1.00**	0.93	0.74	0.69	0.08	0.00	0.05	-0.13	0.56	0.38	0.33	0.44	0.60	0.34	0.28	0.50	0.01	0.01	0.33	0.93	0.08
3	Global Equity IMI	0.98	0.93	**1.00**	0.89	0.82	0.09	-0.01	0.06	-0.14	0.65	0.41	0.36	0.48	0.63	0.35	0.29	0.54	0.01	0.02	0.37	1.00	0.10
4	International Equity (Developed)	0.79	0.74	0.89	**1.00**	0.75	0.05	-0.01	0.05	-0.13	0.61	0.36	0.34	0.44	0.55	0.31	0.26	0.49	0.01	0.03	0.34	0.88	0.11
5	Emerging Markets Equity	0.73	0.69	0.82	0.75	**1.00**	0.07	0.00	0.07	-0.13	0.63	0.34	0.33	0.41	0.53	0.30	0.25	0.46	0.01	0.02	0.37	0.81	0.09
6	Cash (Gov't)	0.09	0.08	0.09	0.05	0.07	**1.00**	0.43	0.23	0.23	0.05	0.20	0.16	0.15	0.10	0.14	0.16	0.18	0.06	0.09	-0.23	0.12	0.41
7	Core Fixed Income	0.00	0.00	-0.01	-0.01	0.00	0.43	**1.00**	0.88	0.80	0.20	0.11	0.05	0.04	0.01	0.04	0.03	0.05	0.00	0.00	-0.03	0.08	-0.01
8	Long Duration Bonds – Credit	0.06	0.05	0.06	0.05	0.07	0.23	0.88	**1.00**	0.81	0.35	0.16	0.05	0.05	0.06	0.05	0.03	0.06	-0.01	-0.02	0.15	0.14	-0.11
9	Long Duration Bonds – Gov't	-0.13	-0.13	-0.14	-0.13	-0.13	0.23	0.80	0.81	**1.00**	-0.15	-0.07	-0.04	-0.06	-0.11	-0.04	-0.05	-0.06	-0.02	-0.04	-0.28	-0.06	-0.16
10	Multi-Asset Credit	0.61	0.56	0.65	0.61	0.63	0.05	0.20	0.35	-0.15	**1.00**	0.45	0.22	0.29	0.40	0.22	0.19	0.33	0.02	0.02	0.70	0.66	0.10
11	Hedge Funds - Low Beta	0.40	0.38	0.41	0.36	0.34	0.20	0.11	0.16	-0.07	0.45	**1.00**	0.19	0.23	0.29	0.18	0.16	0.26	0.01	0.03	0.29	0.42	0.11
12	Core Real Estate	0.35	0.33	0.36	0.34	0.33	0.16	0.05	0.05	-0.04	0.22	0.19	**1.00**	0.96	0.32	0.19	0.16	0.85	0.01	0.01	0.12	0.37	0.09
13	Non-Core Real Estate	0.46	0.44	0.48	0.44	0.41	0.15	0.04	0.05	-0.06	0.29	0.23	0.96	**1.00**	0.38	0.22	0.19	0.89	0.02	0.02	0.16	0.48	0.10
14	Private Equity	0.62	0.60	0.63	0.55	0.53	0.10	0.01	0.06	-0.11	0.40	0.29	0.32	0.38	**1.00**	0.33	0.27	0.45	0.01	0.02	0.27	0.63	0.08
15	Infrastructure	0.35	0.34	0.35	0.31	0.30	0.14	0.04	0.05	-0.04	0.22	0.18	0.19	0.22	0.33	**1.00**	0.81	0.64	0.01	0.02	0.13	0.36	0.08
16	Real Assets (PERA)	0.29	0.28	0.29	0.26	0.25	0.16	0.03	0.03	-0.05	0.19	0.16	0.16	0.19	0.27	0.81	**1.00**	0.52	0.51	0.47	0.11	0.30	0.19
17	Closed-End Real Assets	0.52	0.50	0.54	0.49	0.46	0.18	0.05	0.06	-0.06	0.33	0.26	0.85	0.89	0.45	0.64	0.52	**1.00**	0.01	0.02	0.19	0.54	0.12
18	Farmland	0.01	0.01	0.01	0.01	0.01	0.06	0.00	-0.01	-0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.51	0.01	**1.00**	0.32	0.00	0.01	0.13
19	Timber	0.01	0.01	0.02	0.03	0.02	0.09	0.00	-0.02	-0.04	0.02	0.03	0.01	0.02	0.02	0.02	0.47	0.02	0.32	**1.00**	0.01	0.02	0.21
20	Private Debt	0.34	0.33	0.37	0.34	0.37	-0.23	-0.03	0.15	-0.28	0.70	0.29	0.12	0.16	0.27	0.13	0.11	0.19	0.00	0.01	**1.00**	0.36	-0.01
21	Opportunistic (PERA)	0.97	0.93	1.00	0.88	0.81	0.12	0.08	0.14	-0.06	0.66	0.42	0.37	0.48	0.63	0.36	0.30	0.54	0.01	0.02	0.36	**1.00**	0.10
22	Inflation	0.09	0.08	0.10	0.11	0.09	0.41	-0.01	-0.11	-0.16	0.10	0.11	0.09	0.10	0.08	0.08	0.19	0.12	0.13	0.21	-0.01	0.10	**1.00**

Aon Investments’ Capital Market Assumptions

Explanation of Capital Market Assumptions—09/30/2023

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 third quarter of 2023. 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. Expected returns are using Aon 30 Year Capital Market Assumptions as of 09/30/2023. CMAs contain projections about future returns on asset classes. Our CMA projections are designed to reflect the typical cost of implementing an investment program. Expected returns are calculated using weighted allocations of the underlying CMAs. Expected Returns are geometric (long-term compounded; rounded to the nearest decimal) assuming portfolio weights are rebalanced annually. 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. Aon's advisory fees are described in Part 2A of Aon's Form ADV. Not a guarantee of future results.

Inflation – Expected Level (2.3%)

Based on Consensus Economics long-term estimates and our near-term economic outlook, we expect U.S. consumer price inflation to be approximately 2.3% during the next 30 years.

Real Returns for Asset Classes

Fixed Income		
Cash	1.9%	Over the long run, we expect the real yield on cash and money market instruments to produce a real return of 1.9% in a moderate to low-inflationary environment.
TIPS	2.2%	We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about 2.2%.
Core Fixed Income (i.e., Market Duration)	2.6%	We expect intermediate duration Treasuries to produce a real return of about 1.9%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.7%, resulting in a long-term real return of 1.8%.

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Fixed Income		
Core Plus Bonds	3.0%	Modeled as 20% 5 duration gov't with real return of 1.9% and 80% 5 duration corporate bonds with real return of 3.3%.
Long Duration Bonds – Government and Credit	3.1%	We expect Treasuries with a duration of ~14 years to produce a real return of 2.6%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.5%, resulting in an expected real return of 3.1%.
Long Duration Bonds – Credit	3.8%	We expect Treasuries with a duration of ~12 years to produce a real return of 2.6%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 1.2%, resulting in an expected real return of 3.8%.
Long Duration Bonds – Government	2.6%	We expect Treasuries with a duration of ~16 years to produce a real return of 2.6% during the next 30 years.
High Yield Bonds	3.9%	We expect intermediate duration Treasuries to produce a real return of about 1.9%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 2.0%, resulting in an expected real return of 3.9%.
Bank Loans	4.1%	We expect LIBOR to produce a real return of about 2.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults) to be 1.6%, resulting in an expected real return of 4.1%.
Non-U.S. Developed Bonds: 50% Hedged	2.1%	We forecast real returns for non-US developed market bonds to be 2.1% 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)	4.2%	We forecast real returns for emerging market sovereign bonds denominated in US dollars to be 4.2% over a 30-year period.
Emerging Market Bonds (Corporate; USD)	3.9%	We forecast real returns for emerging market corporate bonds denominated in US dollars to be 3.9% over a 30-year period.

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Emerging Market Bonds (Sovereign; Local)	3.7%	We forecast real returns for emerging market sovereign bonds denominated in local currency to be 3.7% over a 30-year period.
Multi-Asset Credit (MAC)	4.1%	We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 4.1% over a 30-year period.
Private Debt-Direct Lending	5.3%	The base building block is bank loans 4.1% + spread 1.2% (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 US. Equity	4.6%	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	5.1%	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 5.1%. 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.
Global Equity (Developed & Emerging Markets	5.0%	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 5.0% for global equity.
International (Non-U.S.) Equity, Developed Markets	4.6%	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	4.9%	We employ a building block process similar to the U.S. equity model using the non-U.S. emerging equity markets that comprise the MSCI Emerging Markets Index.
Equity Risk Insurance Premium Strategies-High Beta	3.6%	We expect real returns from 50% equity + 50% cash beta plus insurance risk premium over the next 30 years.

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Alternative Asset Classes		
Low Beta (Defensive) Hedge Funds	2.8%	Encompasses defensive/low volatility hedge fund strategies with low correlations to risk assets. This assumption represents median manager performance. 1% base fee + 10% performance fee is deducted from the return expectation.
Low Beta (Defensive) Hedge Funds Buy List	3.8%	Represent top-tier defensive/low volatility hedge fund strategies with low correlations to risk assets. 1% base fee + 7% performance fee is deducted from return expectations. To use this category the funds must be buy rated or we advise on manager selection.
High Beta (Return Enhancing) Hedge Funds	3.8%	Encompasses return enhancing/higher volatility hedge fund strategies with higher correlations to risk assets. The assumption represents median manager performance. 1% base fee + 10% performance fee is deducted from the return expectations.
High Beta (Return Enhancing) Hedge Funds Buy List	5.8%	Represents top-tier return enhancing/higher volatility hedge fund strategies with higher correlations to risk assets. 1% base fee + 7% performance fee is deducted from return expectations. To use this category the funds must be buy rated or we advise on manager selection.
Broad Hedge Funds Universe	3.3%	Generic hedge fund investments which represents a portfolio of diversified strategies. We assume 50% defensive/50% return enhancing strategies. 1% base fee + 10% performance fee is deducted from the return expectations.
Broad Hedge Funds Buy List	4.8%	Generic hedge fund investments which represents a portfolio of top-tier diversified strategies. We assume 50% defensive buy list/50% return enhancing buy list strategies. To use this category the funds must be buy rated or we advise on manager selection. 1% base fee + 7% performance fee is deducted from the return expectations.
Core Real Estate	3.1%	Our real return assumption for core real estate is based a gross income of about 3.6%, 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	4.8%	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 2% over core real estate. We assume a 50/50 mix of value-add and opportunistic investments.
U.S. REITs	4.2%	Our real return assumption for U.S. REITs is based on income of about 4.4% 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.

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Commodities	4.1%	Our 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., 2.3%). Collateral is assumed to be Gov't cash (1.9%). Also, we believe the roll effect will be near zero, resulting in a real return of about 4.1% 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	4.7%	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 4.7% for infrastructure.
Equity Risk Insurance Premium Strategies-Low Beta	4.3%	We assume real returns from cash of 1.9% + 2.4% from alpha.
eLDI	4.0%	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	6.1%	Modeled as 50% Non-Core Real Estate and 50% Infrastructure

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.

Capital Market Assumptions Peer Comparison

Aon assumptions are close to the Horizon Survey median for return and volatility across many asset classes

	Horizon Survey		Aon Investments		Difference	
	10-Year Assumptions		10-Year Assumptions		Aon Investments – Horizon Survey	
Asset Class	**Expected Return**	**Expected Risk**	**Expected Return**	**Expected Risk**	**Expected Return**	**Expected Risk**
U.S. Equity - Large Cap	6.9%	16.6%	6.6%	17.0%	-0.3%	0.4%
U.S. Equity - Small/Mid Cap	7.2%	20.5%	6.8%	23.0%	-0.4%	2.5%
Non-U.S. Equity – Developed	7.4%	18.3%	7.1%	20.5%	-0.3%	2.2%
Non-U.S. Equity – Emerging	7.9%	23.9%	7.3%	24.0%	-0.6%	0.1%
U.S. Fixed Income – Core	4.7%	5.9%	4.3%	5.0%	-0.4%	-0.9%
U.S. Fixed Income - Long Duration Corp	4.9%	10.9%	5.5%	10.5%	0.6%	-0.4%
U.S. Fixed Income - High Yield	6.4%	10.0%	6.0%	10.5%	-0.4%	0.5%
Non-U.S. Fixed Income – Developed	3.3%	7.3%	3.6%	6.0%	0.3%	-1.3%
Non-U.S. Fixed Income – Emerging	6.3%	10.9%	7.1%	11.0%	0.8%	0.1%
Treasuries (Cash Equivalents)	3.3%	1.1%	3.5%	1.5%	0.2%	0.4%
TIPS (Inflation-Protected)	4.1%	6.2%	3.6%	4.5%	-0.5%	-1.7%
Real Estate	6.1%	16.7%	5.6%	15.0%	-0.5%	-1.7%
Hedge Funds	5.9%	8.1%	6.2%	9.0%	0.3%	0.9%
Commodities	4.9%	18.0%	6.5%	17.0%	1.6%	-1.0%
Infrastructure	6.9%	17.1%	7.1%	14.5%	0.2%	-2.6%
Private Equity	9.6%	22.6%	9.1%	25.0%	-0.5%	2.4%
Private Debt	8.1%	11.7%	9.0%	16.5%	0.9%	4.8%
Inflation	2.5%	1.9%	2.3%	1.5%	-0.2%	-0.4%

Notes (Horizon Survey):

Source: Horizon Actuarial survey of 2023 capital market assumptions from 42 independent investment advisors

Expected returns are median annualized (geometric).

Notes (Aon Investments' Assumptions):

Aon Investments' assumptions are for Q2 2023

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

Aon Investments' expected returns are annualized over 10-years as of 2Q 2023 (3/31/2023). CMAs contain projections about future returns on asset classes. Our CMA projections are designed to reflect the typical cost of implementing an investment program. Not a guarantee of future results. Additional information regarding our capital market assumptions can be made available upon request.

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