Callan

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North Carolina Retirement System

Asset Allocation and Liability Study:
Meeting 1

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Outline

Overview of asset/liability modeling process

Capital market assumption development

Overview of liability model assumptions and output

Overview of asset simulation for current policy

Overview of simulated funding ratio and contributions for current policy

Introduce asset allocation themes to be evaluated

} Today's agenda

Present results of asset/liability evaluation of candidate policy mixes
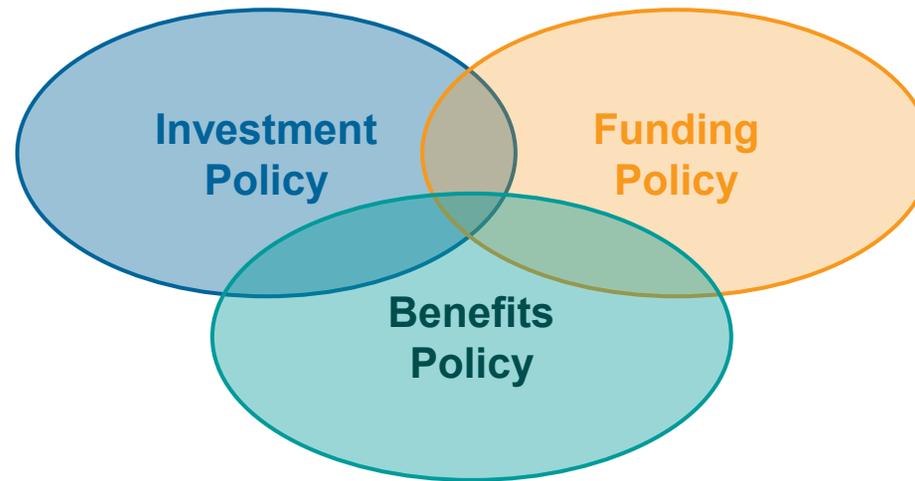
} February meeting
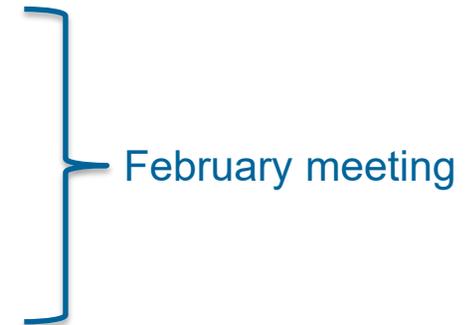
Callan Approach to Asset Allocation

Evaluate the interaction of three key strategic policies that govern a defined benefit plan with the goal of establishing the best investment policy

Investment Policy
- Return objective
- Risk tolerance
- Liquidity needs

Investment Policy

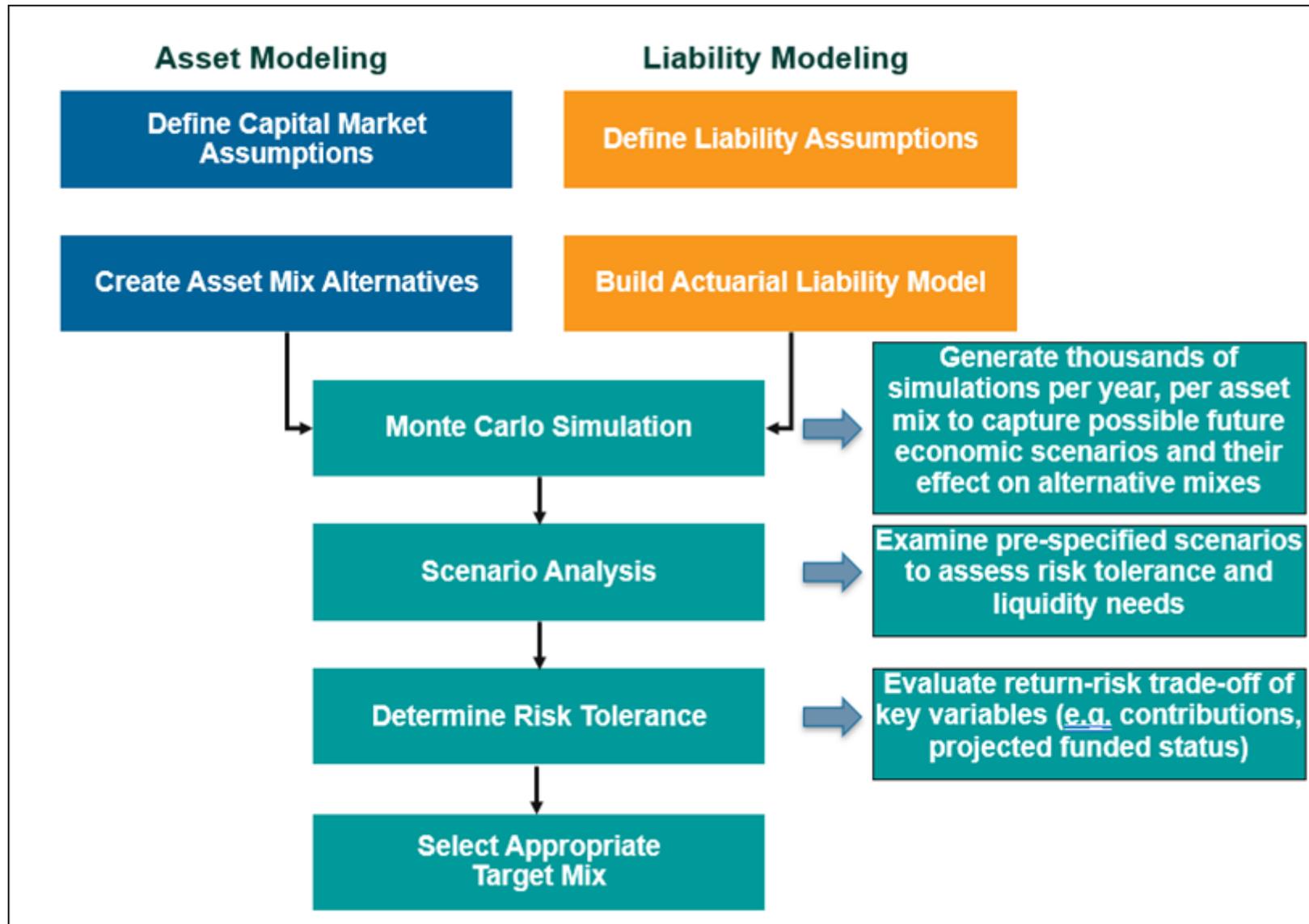**Funding Policy**

Benefits Policy

Funding Policy
- Assumed investment return
- Actuarial methodologies employed to stabilize contributions

Benefits Policy
- Nature of benefit promise (liability)
- Ongoing cost of benefits (normal cost)
- Plan type: Open, Closed, Frozen

Callan Asset/Liability Process

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Capital Market Assumption Development

Capital Market Assumptions

Asset class expected returns are projected for both the next 10 and 30 years

- These projections reflect the collective view of Callan and NC IMD staff

Equity expected returns incorporate macroeconomic variables such as GDP growth and inflation as well as projected income return and valuation considerations

- Equity returns are forecasted to be relatively modest over the next decade
- Over the longer term, equity returns are projected to be more favorable

Bond asset class expected returns are forecasted by anchoring off current bond yields and the current interest rate term structure and incorporating an increase in interest rates over time

- Rising rates drive low fixed income returns over the next decade
- Higher future yields result in higher expected returns over the 30 year horizon

Alternative asset class expected returns are projected by blending baseline projections with NCRS specific implementation considerations as well as actual historical experience

Forecasts for asset class risks and correlations are also required to understand the behavior of the current portfolio as well the impact of potential asset allocation changes

- Higher asset class expected returns are linked with higher risks

NCRS Policy and Modeling Framework

Asset Class	Policy Weight	Modeled With:
Growth (Return Seeking)	**58%**	
Global Equity	42%	Equity Model
Private Equity	6%	Alts Model
Non Core Real Estate	3%	Alts Model
Opportunistic Fixed Income	7%	Bond Model
Rates and Liquidity (Risk Reducing)	**29%**	
IG Fixed Income and Cash	28%	Bond Model
Cash	1%	Bond Model
Inflation Sensitive and Diversifiers	**11%**	
Inflation Sensitive	6%	Alts Model
Core Real Estate	5%	Alts Model
Multistrategy	**2%**	Alts Model

High level discussion of the equity, bond, and alternatives models follows

Equity Model

Overview

Fundamental Relationship:

Equity Return =   **Capital Appreciation**   **+ Income**   **+/- Valuation Adjustment**

Real Earnings Growth + Inflation

Over the next decade, U.S. Equity (S&P 500) forecasted at 6.75%; Global Equity (ACWI IMI) forecasted at 7.10%

- Building up US equity returns from long-term fundamentals results in a 6.75% annualized return
  - *Real earnings growth is linked to real GDP growth over long horizons; we forecast US real GDP of 2.25% over the next decade*
  - *Inflation(CPI-U) forecasted at 2.25%*
    - *Consistent with Fed's inflation target*
    - *Consistent with realized inflation over the past three decades*
    - *In line with the market-based forecast of breakeven inflation (yield difference between Treasuries and TIPS)*
  - *Income return of 2.50% from dividend yield and net share buybacks*
  - *0.25% reduction based on high current US valuations*

- Small return premium for global equity over US equity stems from valuation considerations, higher international dividends and emerging market growth potential

Over the 30 year horizon, Global Equity is forecasted at 7.40%

- Global equities have returned 5.3% above inflation/year from 1900-2020

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Bond Model: Expected Returns Are Driven by the Path of Treasury Yields

Smoothed Yield Paths
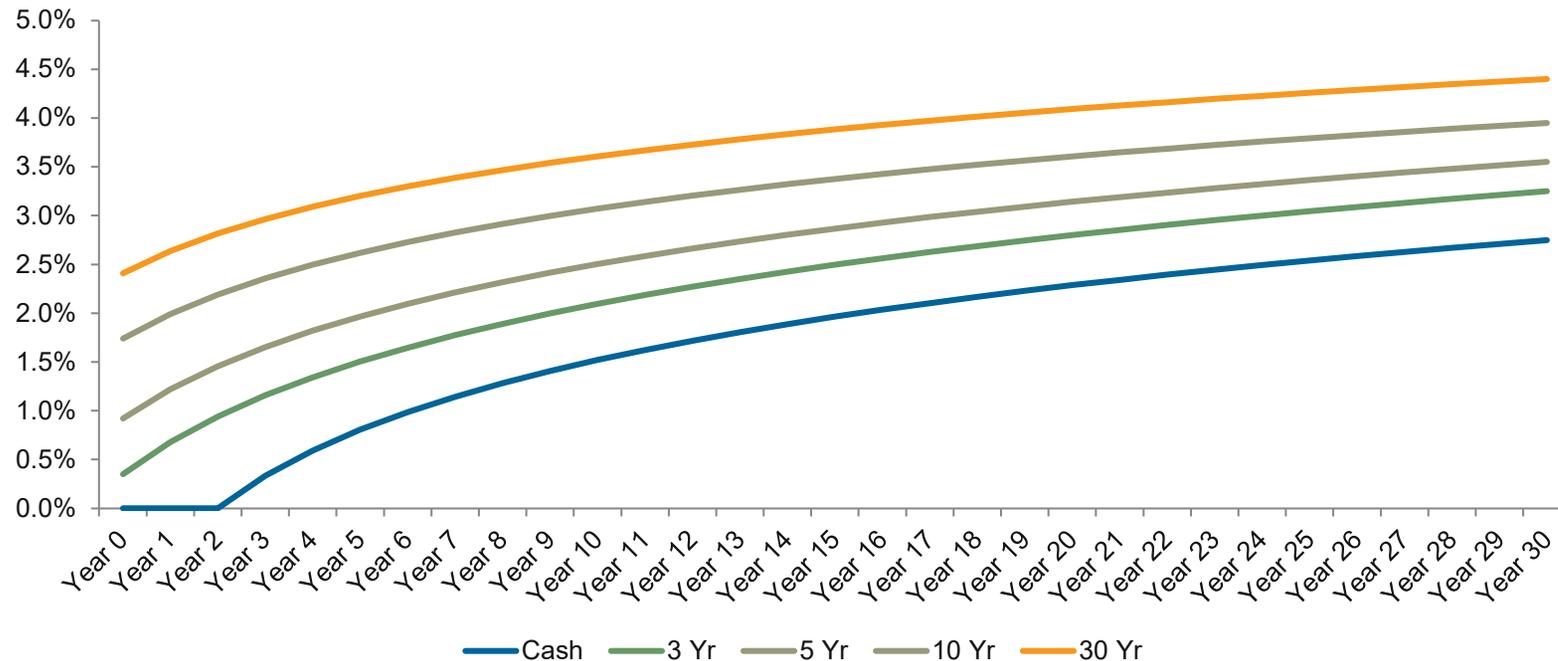
Rising yield projections translate into low bond returns over the next decade, higher returns thereafter

Cash at end of the 30-year horizon is 2.75%

- Reflects a 50 basis point premium over projected inflation which is consistent with long-term US interest rate history

- Cash projected to start to increase from current 0% in Year 2 in line with market expectations

Term premiums are consistent with long-term historical averages

- For example, in Year 30, the 30-year Treasury yield is 4.4%, or 1.65% above cash

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Bond Model: Results

Expected return forecasts

	10 Year Expected Return	30 Year Expected Return
Cash	0.75%	1.75%
1-3 Year TIPS	1.25%	2.25%
Investment Grade Bonds (Aggregate)	1.75%	3.05%
Custom Investment Grade (5+ years)	1.95%	3.45%
High Yield	4.25%	6.40%
Bank Loans	5.15%	6.15%

10-year bond projections are lower than the 30-year projections

- Rising rates drive low fixed income returns over the next decade

- Higher future yields result in higher expected returns over the 30 year horizon

NCRS currently has a custom investment grade (IG) allocation composed of 5+ year maturity bonds

- In the asset-liability study, custom IG bond asset class characteristics will be assessed relative to a shorter maturity IG Aggregate allocation

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Alternative Investment Modeling

Private equity, private real estate, opportunistic fixed, inflation sensitive, and hedge funds

Private equity projected with a 2% return premium over global equity

- Premium is consistent with NCRS historical program results

- Private equity is driven by similar economic factors as global equity but modelled with a higher risk

Private core real estate projected at 6.00% return over next decade, 6.40% over 30 years

- Based on projections for income and capital appreciation

- Asset class characteristics fall in between public equity and fixed income

Non core real estate modeled with a 2% premium over private core real estate

- Consistent with NCRS historical program results and well as adjusting expected returns for greater risk

- Asset class risks are scaled upward accordingly as well

Opportunistic fixed income projected at 5.80% return over next decade, 6.75% over 30 years

- Modeled as 50% distressed debt, 25% high yield, and 25% bank loans

- As a component of NCRS's growth allocation, primary role is to grow the asset pool rather than provide defensive characteristics

Inflation sensitive projected at a 4.25% return over next decade; 4.80% over 30 years

- Currently modeled as 33% 1-3 TIPS, 17% Public Commodities, 25% Infrastructure, 25% Private Real Estate

- Will also evaluate this bucket without the commodities allocation, which will increase both expected return and risk

Multistrategy (Hedge Funds) projected at 4.25% return over next decade; 5.00% over 30 years

- Modeled as cash returns plus an equity beta of 0.4 from market exposure and 1% return from non-conventional market exposure
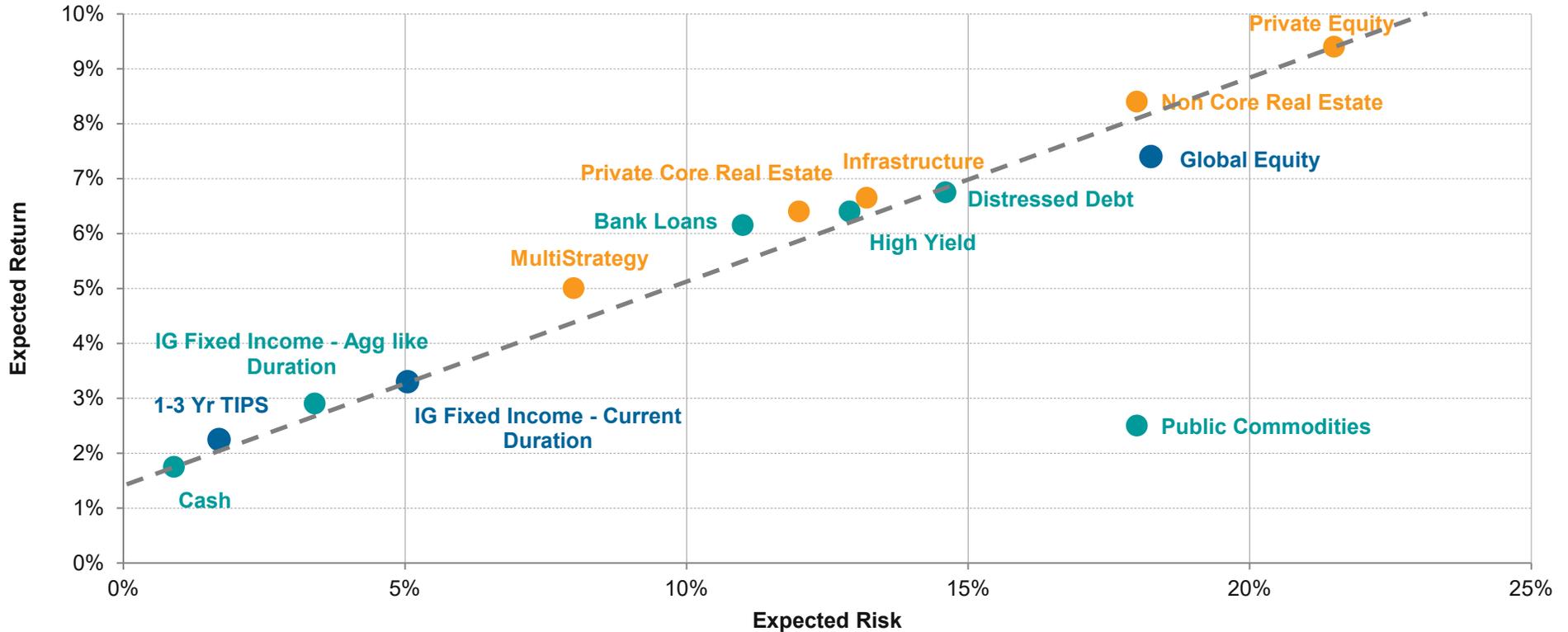
Asset Class Expected Returns and Risks

Table 1: NCRS Asset Class Forecasts	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
Global Equity	7.10%	7.40%	18.25%	MSCI ACWI IMI
Private Equity	9.10%	9.40%	21.50%	Global Equity + 2%
Non Core Real Estate	8.00%	8.40%	18.00%	Private Core RE + 2%; Risk 150% of Private Core RE
Opportunistic Fixed Income	5.80%	6.70%	11.60%	See Table 2 below for detail
IG Fixed Income - Current Duration	1.85%	3.30%	5.05%	90% NC Custom IG BM 5+yr/10% Cash
IG Fixed Income - Agg like Duration	1.65%	2.90%	3.40%	90% Agg BM/10% Cash
Cash	0.75%	1.75%	0.90%	90 Day T-Bill
Core Real Estate	6.25%	6.65%	12.85%	80% NCREIF ODCE/20% REITS
Inflation Sensitive	4.25%	4.80%	7.20%	See Table 3 below for detail
Inflation Sensitive ex Commodities	4.70%	5.30%	7.90%	See Table 4 below for detail
MultiStrategy	4.25%	5.00%	8.00%	CS Hedge Fund Index
Inflation Rate	2.25%	2.25%	1.50%	

Table 2: Opportunistic Fixed Income Components	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
Distressed Debt (50%)	6.50%	6.75%	14.60%	Distressed Loans
High Yield (25%)	4.25%	6.40%	12.90%	Barclays HY Corporate
Bank Loans (25%)	5.15%	6.15%	11.00%	CS Levered Loans

Table 3: Inflation Sensitive Components	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
1-3 yr TIPS (33%)	1.25%	2.25%	1.70%	Bloomberg TIPS 1-3yr
Public Commodities (17%)	2.50%	2.50%	18.00%	Bloomberg Commodity
Infrastructure (25%)	6.25%	6.65%	13.20%	Modeled as Private
Private Core Real Estate (25%)	6.00%	6.40%	12.00%	NCREIF ODCE

Table 4: Inflation Sensitive ex- Comm Components	10 Yr Expected Return	30 Yr Expected Return	Risk	Notes on proxy used
1-3 yr TIPS (33%)	1.25%	2.25%	1.70%	Bloomberg TIPS 1-3yr
Infrastructure (33%)	6.25%	6.65%	13.20%	Modeled as Private
Private Core Real Estate (33%)	6.00%	6.40%	12.00%	NCREIF ODCE

All returns are (geometric) annualized.

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Return/Risk Characteristics

30 year assumptions

Higher asset class expected returns are linked with higher risks

- For example, non core real estate has both a higher expected return and risk than private core real estate

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Incorporating the Liability

# TSERS Current Financial Position and Funding Policy

- Liability model is based on the 12/31/2019 and 12/31/2020 TSERS actuarial valuation reports

- Simulations start at 12/31/2020
  - 2020 actual investment experience of 11.12%

- Callan and Cavanaugh Macdonald utilize the same actuarial software
  - Cavanaugh Macdonald provided Callan with a liability model
  - Callan conducted the asset modelling

- Funding Policy = Normal Cost + Amortization of Unfunded Liability/(Surplus) subject to stable contributions until 6/30/2027
  - The funding policy modelled approximates the Employer Contribution Rate Stabilization Policy (ECRSP) which is in force to 6/30/2027 by assuming that contributions modestly (~0.35%) ratchet up every year until 2027
  - Amortization bases have been set up every year since 2009 and are paid down over the next 12 years
  - Future unfunded liability/(surplus) that develops in future years is amortized over a closed 12-year period
  - Employer contribution rate minimum = 6.0%

	12/31/2019	12/31/2020
Actuarial Accrued Liability	$84,873M	$89,809M
Discount Rate	7.0%	6.5%
Market Value of Assets	$75,487M	$81,969M
Actuarial Value of Assets	$73,354M	$77,922M
Market Funded Status (MVA/AL)	88.9%	91.2%
Actuarial Funded Status (AVA/AL)	86.4%	86.8%
Required Employer Rate NCGS 135-8(d)	16.09%	15.74%

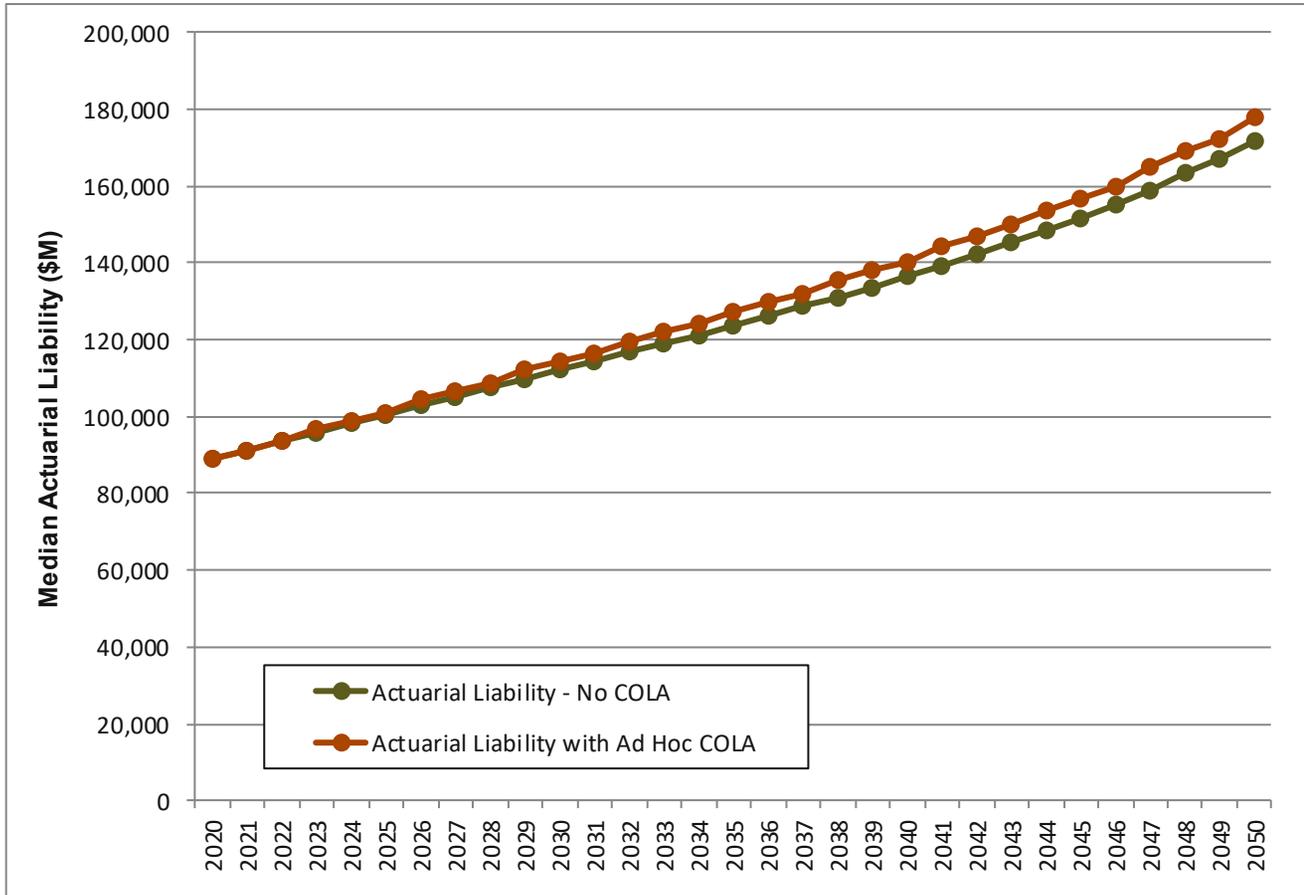|	Actuarial Assumption	Callan 10-year Expectation	Callan 30-year Expectation
Investment Return	6.5%	5.8% *	6.5% *
Price Inflation	2.5%	2.25%	2.25%

* Based on current policy target

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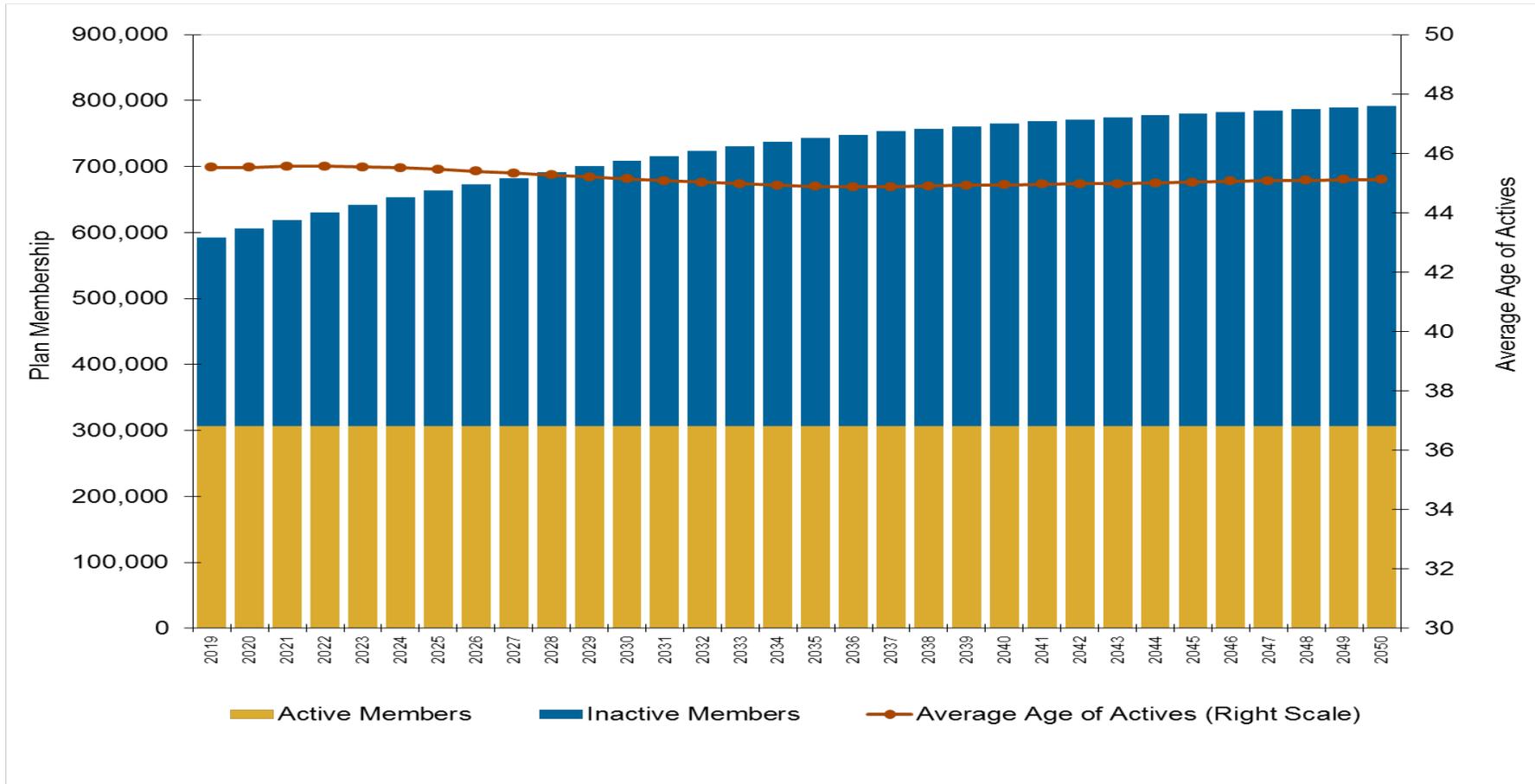
Plan Membership

- Active members are held constant at 305,962
  - Future new hires replace exits due to retirement, death, disability, and withdrawal.
  - A constant active membership implies 0% workforce growth
  - Average age of actives is constant over the forecast horizon ~ age 45

Ad Hoc COLA Assumptions

Median Actuarial Liability ($M) — chart with years 2020–2050

Legend:
- Actuarial Liability - No COLA
- Actuarial Liability with Ad Hoc COLA

TSERS Ad hoc COLA History Relative to CPI-U

	Total Allowance Increase	National CPI-U
1989	6.70%	4.60%
1990	0.00%	6.10%
1991	5.20%	3.10%
1992	2.20%	2.90%
1993	4.70%	2.70%
1994	3.20%	2.70%
1995	4.40%	2.50%
1996	6.20%	3.30%
1997	2.50%	1.70%
1998	2.30%	1.60%
1999	4.20%	2.70%
2000	2.00%	3.40%
2001	2.00%	2.60%
2002	1.30%	2.40%
2003	1.70%	1.90%
2004	2.00%	3.30%
2005	3.00%	3.40%
2006	2.20%	2.50%
2007	2.20%	4.10%
2008	0.00%	0.10%
2009	0.00%	2.70%
2010	0.00%	1.50%
2011	1.00%	3.00%
2012	0.00%	1.70%
2013	1.00%	1.50%
2014	0.00%	0.80%
2015	0.00%	0.70%
2016	1.00%	2.10%
2017	0.00%	2.10%
2018	0.00%	1.90%
2019	0.00%	2.30%

* Page 85 of TSERS 12/31/2019 Actuarial Report

- Ad Hoc COLA assumptions based on last 10 years of TSERS history:
  - Target 20% of cumulative inflation overtime
  - Maximum COLA per year = 1.0%; Minimum COLA per year = 0.0%
  - Granted once every 3 years
- 30-year annualized growth rate in median actuarial liability:
  - No COLA = 2.21% per year
  - With Ad Hoc COLA = 2.34% per year

Actuarial Accrued Liability with Ad Hoc COLA
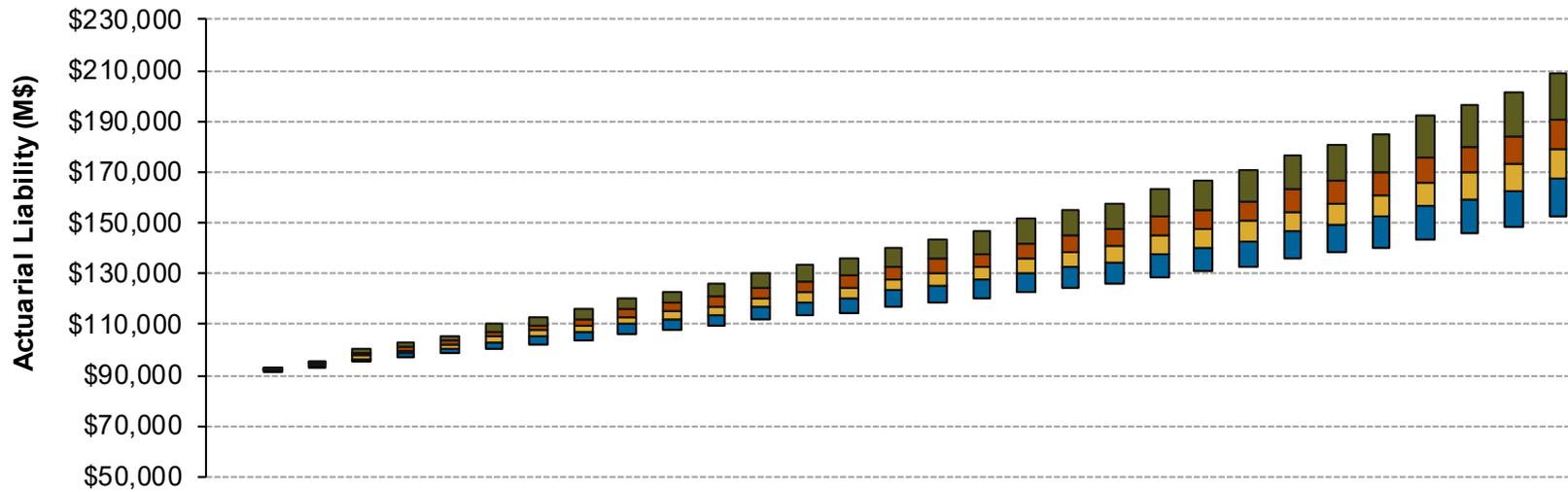
Percentile	2020	2025	2030	2035	2040	2045	2050
97.5th	89,803	106,344	124,602	143,038	161,040	186,168	216,963
95th	89,803	105,729	123,078	140,412	157,591	180,690	209,126
75th	89,803	103,476	118,225	132,974	147,669	166,742	190,548
50th	89,803	101,971	115,013	128,090	141,104	157,611	178,779
25th	89,803	100,611	112,084	123,564	134,483	149,348	167,498
5th	89,803	98,698	107,972	116,882	125,986	138,159	152,609
Range (5th - 95th)		7,032	15,107	23,530	31,606	42,531	56,518

● Plan liabilities are increasing steadily over the next 30 years

  – Liabilities increase with ongoing benefit accrual, passage of time (discount rate) and are reduced by benefit payments

  – 30-Year expected annualized growth in liability is 2.34% per year

  – Discount rate is held constant at 6.5% and ad hoc COLAs are reflected

NCRS Current Policy Weights

Asset Class	Policy Weight
Growth	**58%**
Global Equity	42%
Private Equity	6%
Non Core Real Estate	3%
Opportunistic Fixed Income	7%
Rates and Liquidity	**29%**
IG Fixed Income and Cash	28%
Cash	1%
Inflation Sensitive and Diversifiers	**11%**
Inflation Sensitive	6%
Core Real Estate	5%
Multistrategy	**2%**

Simulated Returns (Current Policy Target)
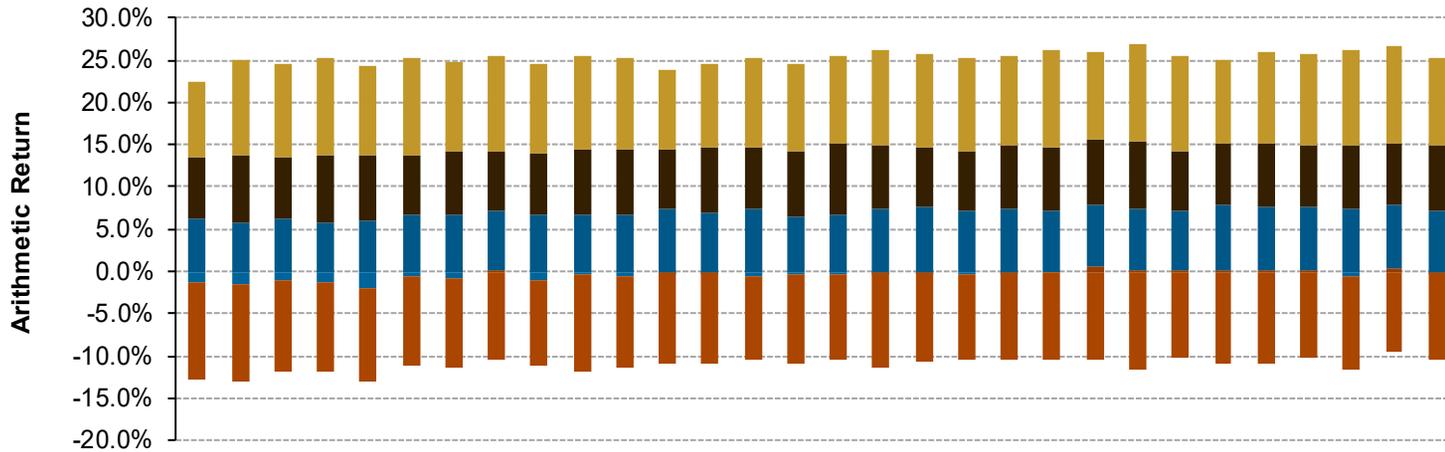
Percentile	Arithmetic Return							Annualized Return		
	2021	2025	2030	2035	2040	2045	2050	10-Year	20-Year	30-Year
5th	22.5%	24.4%	25.5%	24.5%	25.5%	25.1%	25.3%	11.3%	10.1%	9.6%
25th	13.4%	13.6%	14.6%	14.3%	15.0%	15.2%	14.8%	8.1%	7.7%	7.9%
50th	6.1%	6.0%	6.8%	6.5%	7.5%	7.8%	7.1%	5.8%	6.3%	6.5%
75th	-1.2%	-2.0%	-0.4%	-0.5%	-0.1%	0.2%	-0.1%	3.8%	4.8%	5.2%
95th	-12.8%	-12.9%	-12.0%	-10.9%	-10.4%	-11.0%	-10.5%	0.7%	2.5%	3.4%
97.5th	-16.6%	-16.2%	-16.2%	-14.4%	-13.8%	-14.7%	-14.2%	-0.3%	1.8%	2.8%
Prob (>= 6.5%)								42%	46%	50%

- In a given year, a worse case return (95th) can be -10% to -13%

- In a 2 standard deviation event (97.5[th]), worse case return can be -14% to -17%

- The probability of meeting or exceeding a 6.5% return is expected to improve overtime

Market Value of Assets (Current Policy Target)
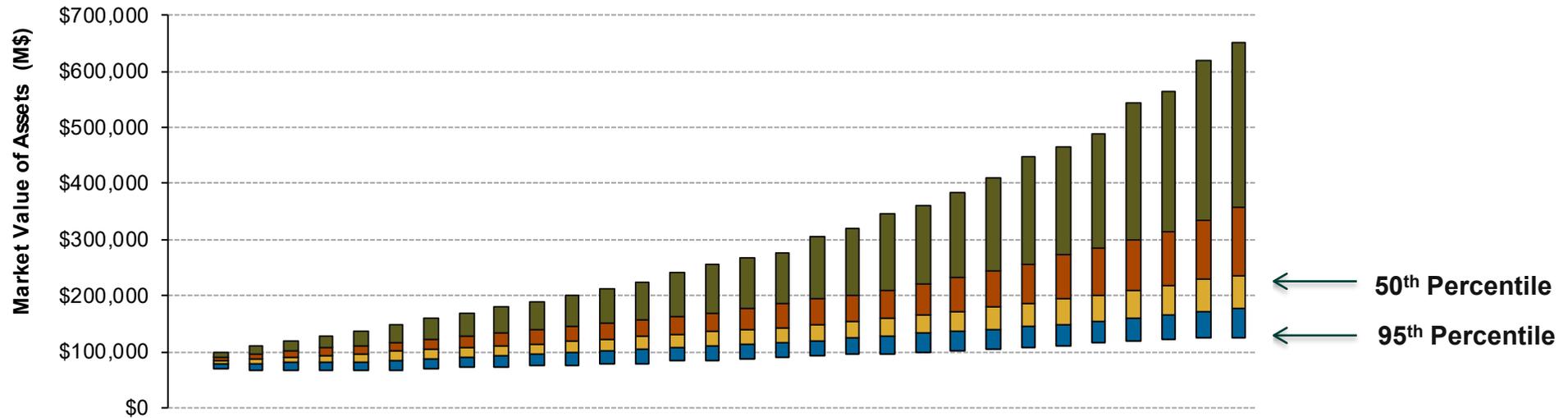
Percentile	2020	2025	2030	2035	2040	2045	2050
5th	$81,969	$137,142	$190,285	$254,995	$344,865	$464,018	$652,796
25th	81,969	110,841	139,308	168,687	209,332	272,019	356,548
50th	81,969	96,712	113,990	135,393	159,902	193,695	235,162
75th	81,969	82,447	94,692	109,070	128,387	148,628	178,437
95th	81,969	67,311	75,076	84,975	97,183	111,340	126,067
97.5th	81,969	61,933	69,849	77,476	88,476	103,370	117,503
Range (5th - 95th)		69,831	115,208	170,020	247,682	352,678	526,729

- The expected outcome is the 50th percentile (50-50 chance of occurrence)

- The worse-case scenarios:
  - 95th percentile: 1-in-20 chance (5% probability) that the 12/31/2050 market value of assets will be $126.1B or less
  - 97.5th percentile: 1-in-40 chance (2.5% probability) that the 12/31/2050 market value of assets will be $117.5B or less

- Floating bars illustrate the range of outcomes from the 5th to the 95th

Funded Status (Current Policy Target)
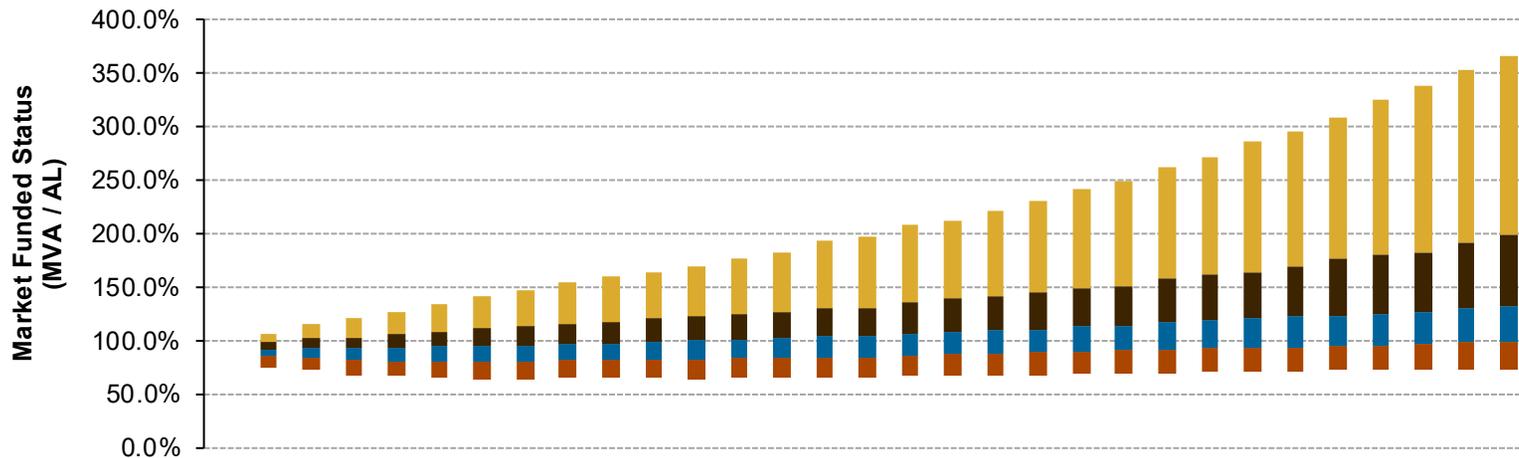
Percentile	2020	2025	2030	2035	2040	2045	2050
5th	91.3%	133.9%	164.3%	197.3%	241.5%	295.5%	366.5%
25th	91.3%	109.0%	121.5%	131.5%	148.5%	170.0%	200.1%
50th	91.3%	94.6%	98.6%	105.1%	113.3%	122.5%	132.4%
75th	91.3%	80.7%	82.4%	84.7%	90.7%	94.3%	98.8%
95th	91.3%	65.7%	65.3%	66.7%	69.6%	71.9%	72.6%
97.5th	91.3%	60.5%	59.8%	62.0%	64.6%	66.6%	66.9%
Prob. 100% Funded	0%	40%	48%	56%	65%	70%	74%

- The Plan is expected to be fully funded in 2031

- Plan may become very overfunded due to minimum employer rate = 6.0% in conjunction with an employee rate = 6.0%

Evaluating Asset Mixes

Three series of asset mix themes will be evaluated across a variety of risk/return profiles

- Set 1: Keeps alternatives at their current policy allocation while shifting allocation from Rates & Liquidity to Growth Assets

- Set 2: Increases alternatives within statutory constraints to improve risk-adjusted returns

- Set 3: Evaluate moderate to higher cash allocations while tilting alternative asset class allocations to those with a higher return profile

Also will evaluate the impact of changes in asset class composition

- We evaluate the impact of migrating the IG bond allocation from 5+ into the Aggregate

- Analysis is supportive of retaining the current 5+ allocation

- Similarly, modeling the inflation sensitive asset class without commodities improves portfolio level characteristics

Next Steps

Present results of asset/liability evaluation of candidate policy mixes

- Candidate mix return and risk projections

- Funded ratio projections by mix

- Contribution projections by mix

- Evaluation of each mix in specified economic environments and market stress scenarios

These results will facilitate a decision on the best asset allocation policy going forward

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