ASSET-LIABILITY STUDY

ARIZONA STATE RETIREMENT SYSTEM

SEPTEMBER 2022

SUMMARY, ANALYSIS & RECOMMENDATION

EXECUTIVE SUMMARY: GOALS & PROCESS

Goals:

Establish policy asset allocation targets, including asset allocation ranges and benchmarks, in order to:

1. Maximize the long term (geometric) average investment rate of return in order to minimize the long term average contribution rate, subject to prudent risk levels.
2. Mitigate contribution rate volatility
3. Achieve long-term full funding
4. Ensure liquidity

Process:

- Correctly identify the appropriate risk metrics
- Determine current capital market assumptions (expected returns and volatilities)
- Project the size of liabilities and the timing of payments
- Conduct various deterministic and stochastic simulations
- Evaluate alternative asset allocations
- Measure the various relevant risk metrics including:
  - Future contribution rate levels
  - Future contribution rate volatility
  - Smoothed Asset Funded status
  - Unsmoothed Asset Funded status
  - Other

Source: ASRS Investment Policies and NEPC

PROCESS

ASSET LIABILITY STUDY

- Obtain Actuarial Valuation from GRS (basis for Liability Projection)
- Release 2022 standard NEPC Capital Market Assumptions Themes, Inflation, 10 year, 30 year returns
- Customize Asset Class Forecasts for the asset classes
- Investment Committee Meeting Provide background on Asset Liability Modeling and Asset Allocation Study. Review Capital Market Assumptions, 10 and 20 year outlook for current allocation and policy targets. Solicit Feedback on changes/concerns
- Review efficient frontiers (including constraints). Propose and evaluate alternate mixes based on return/risk/liquidity
- Evaluate study and stochastic results using current actual and policy target allocation. Present alternate mixes (asset only analysis) for discussion. Choose Revised Policy Targets. Evaluate benchmarks and ranges
- Present Full study including alternate mixes and stochastic results. Approve Revised Investment Policy including Revised Targets, Ranges, and Benchmarks

RECOMMENDATION

	Current			Recommended (Mix 12)		
Asset Class	Policy Target	Range	Benchmark	Policy Target	Range	Benchmark
Equity	50.0%	35%-65%	Asset Weighted: MSCI ACWI IMI Net USA Gross + MSCI ACWI IMI Net USA Gross 1 QTR Lagged			
Public Equity			MSCI ACWI IMI Net USA Gross	44.0%	34%-54%	MSCI ACWI IMI Net USA Gross
Private Equity			MSCI ACWI IMI Net USA Gross 1 QTR Lagged	10.0%	7%-13%	MSCI ACWI IMI Net USA Gross 1 QTR Lagged
Credit	20.0%	10%-30%	S&P LSTA Index 1 QTR Lagged + 2.5%	23.0%	17%-26%	S&P LSTA Index 1 QTR Lagged + 2.5%
Interest Rate Sensitive	10.0%	0%-20%	Bloomberg US Aggregate Bond Index	6.0%	3%-12%	Bloomberg US Treasury Index
Real Estate	20.0%	10%-30%	NCREIF ODCE NET 1 QTR Lagged	17.0%	13%-21%	NCREIF ODCE NET 1 QTR Lagged

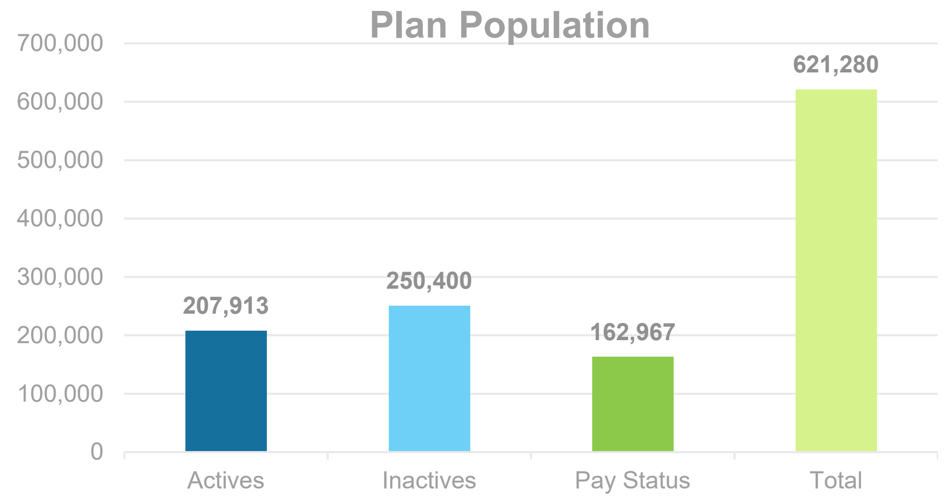
The recommended asset allocation is Mix 12 and includes the following changes:

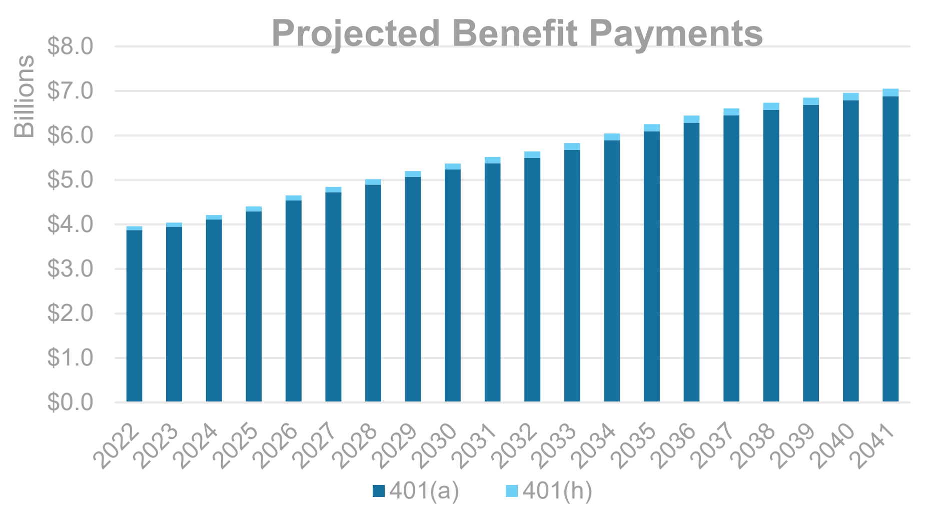
- Increase Public Equity by 4% to: 44% of Total Fund
- Maintain Private Equity at: 10% of Total Fund
- Increase Credit by 3% to: 23% of Total Fund
- Decrease Interest Rate Sensitive by 4% to: 6% of Total Fund
- Change benchmark to Bloomberg US Treasuries Index
- Reduce Real Estate by 3% to: 17% of Total Fund
- Asset class Ranges as presented

ARIZONA STATE RETIREMENT SYSTEM

PLAN CHARACTERISTICS

- **The Arizona State Retirement System administers two main defined benefit plans**
  - Pension Plan: traditional final average salary pension benefits
  - 401(h) Plan: supplemental health premium benefits
- **Pension Plan is by far the main cost driver within the system**
  - Consists of 96% of system assets and 98% of system liabilities
- **As of June 30, 2021 ASRS is 71.5% funded based on a smoothed asset value**
  - 80.0% funded on a market value basis
- **Among other assumption and method changes, the discount rate was decreased from 7.50% to 7.00%**
  - Impact from these changes is being phased-in over 3 years to minimize contribution volatility
- **Strong investment performance in FY21 and smoothed asset methodology will help to balance impact from recent assumption changes**



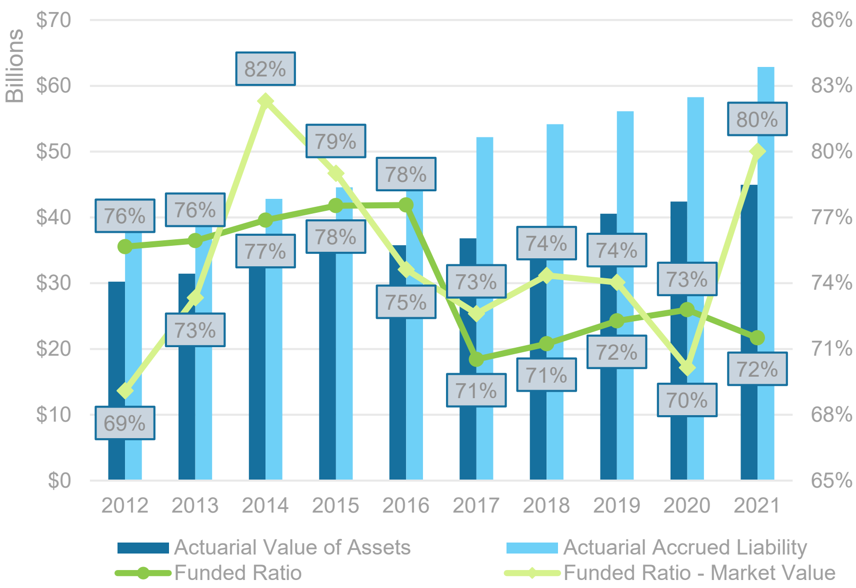


Source: GRS

ARIZONA STATE RETIREMENT SYSTEM

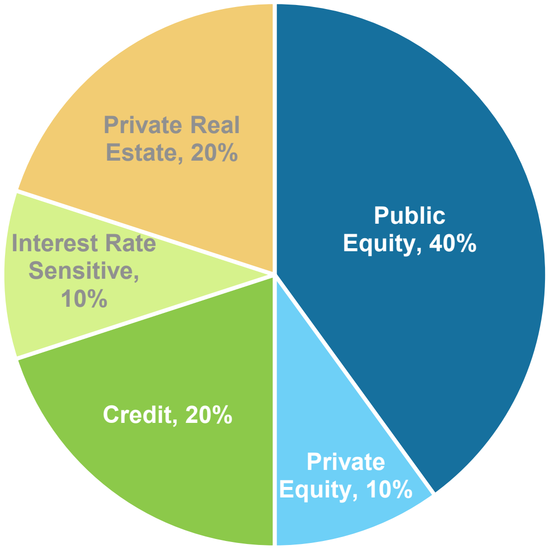
PLAN RISK PROFILE

Funded Status



Liability Discount Rate	**7.0%**
Funded Status	**71.5%**
Contribution Rate	**24.1%**

Asset Allocation[1]



	NEPC Beta	ASRS Alpha
10-Yr Expected Return	**6.8%**	**7.2%**
20-Yr Expected Return	**7.3%**	**7.4%**
Asset Volatility	**9.8%**	**9.3%**

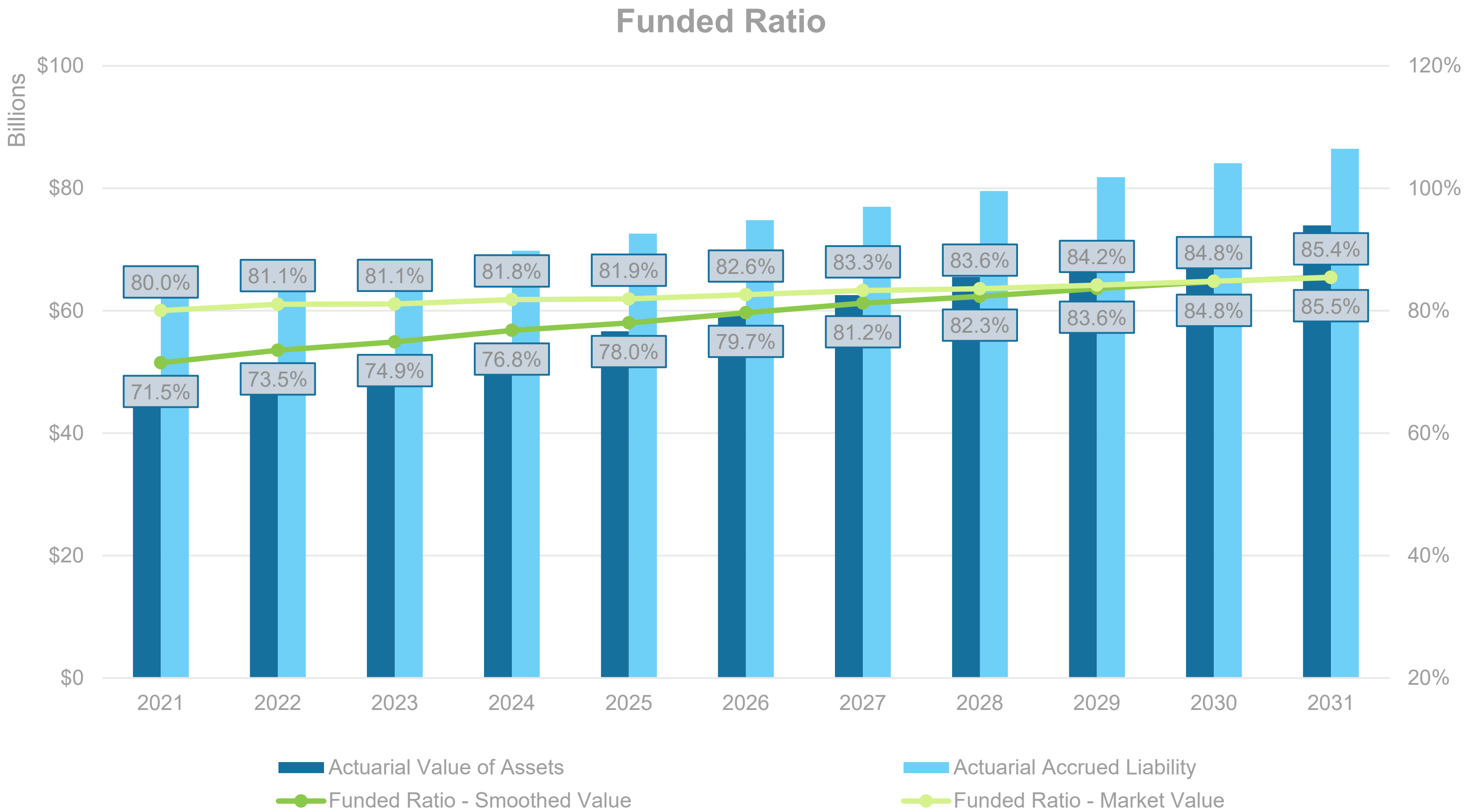
Notes: [1] Current Policy targets

CURRENT POLICY DETERMINISTIC PROJECTIONS

ARIZONA STATE RETIREMENT SYSTEM

10-YR FUNDED STATUS PROJECTION – PENSION & BENEFIT

NEPC BETA RETURN ASSUMPTIONS

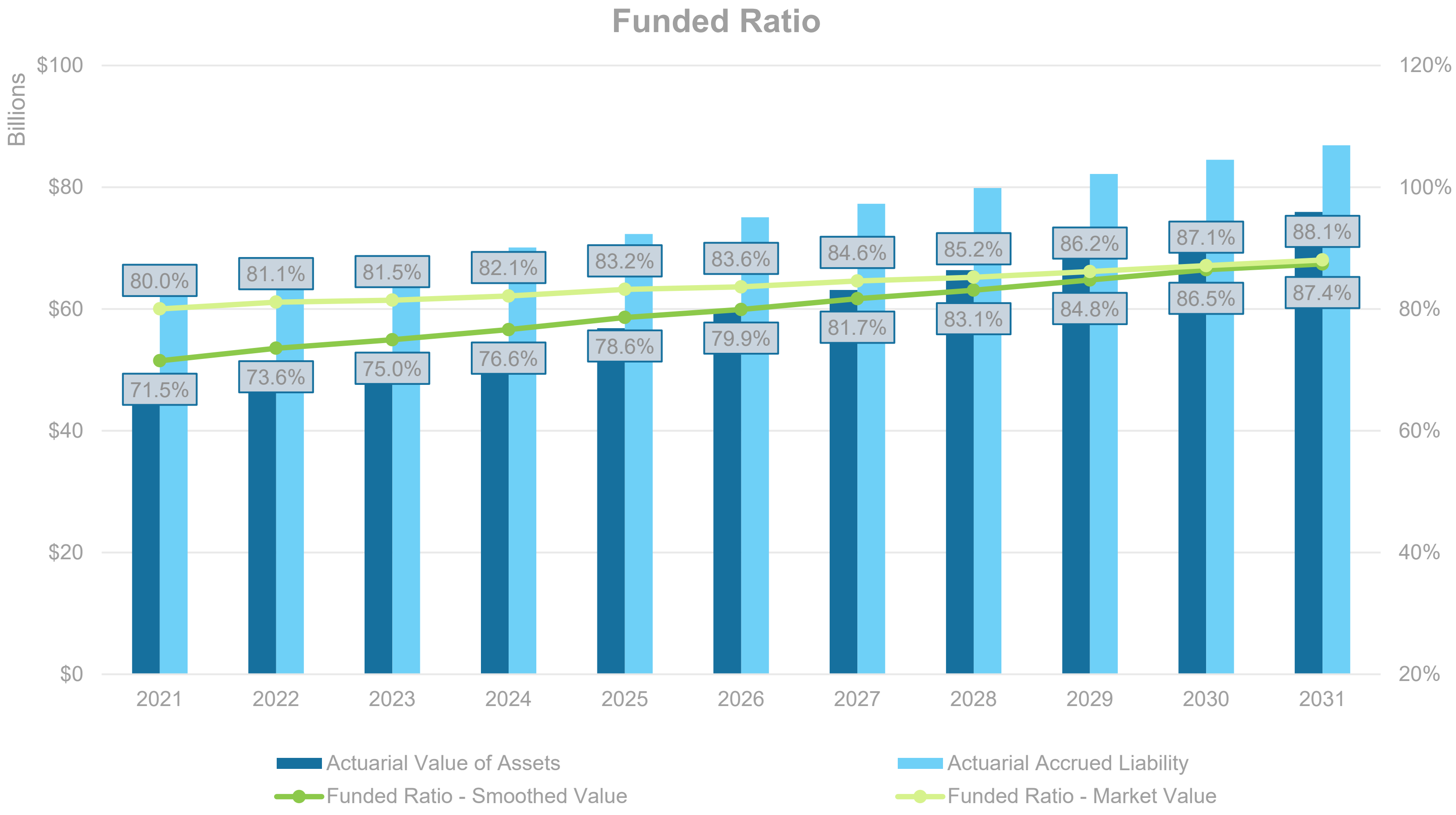


Notes: As of June 30; Assumes Current Policy allocation NEPC Beta 10-yr expected return of 6.8% per annum

ARIZONA STATE RETIREMENT SYSTEM

10-YR FUNDED STATUS PROJECTION – PENSION & BENEFIT

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

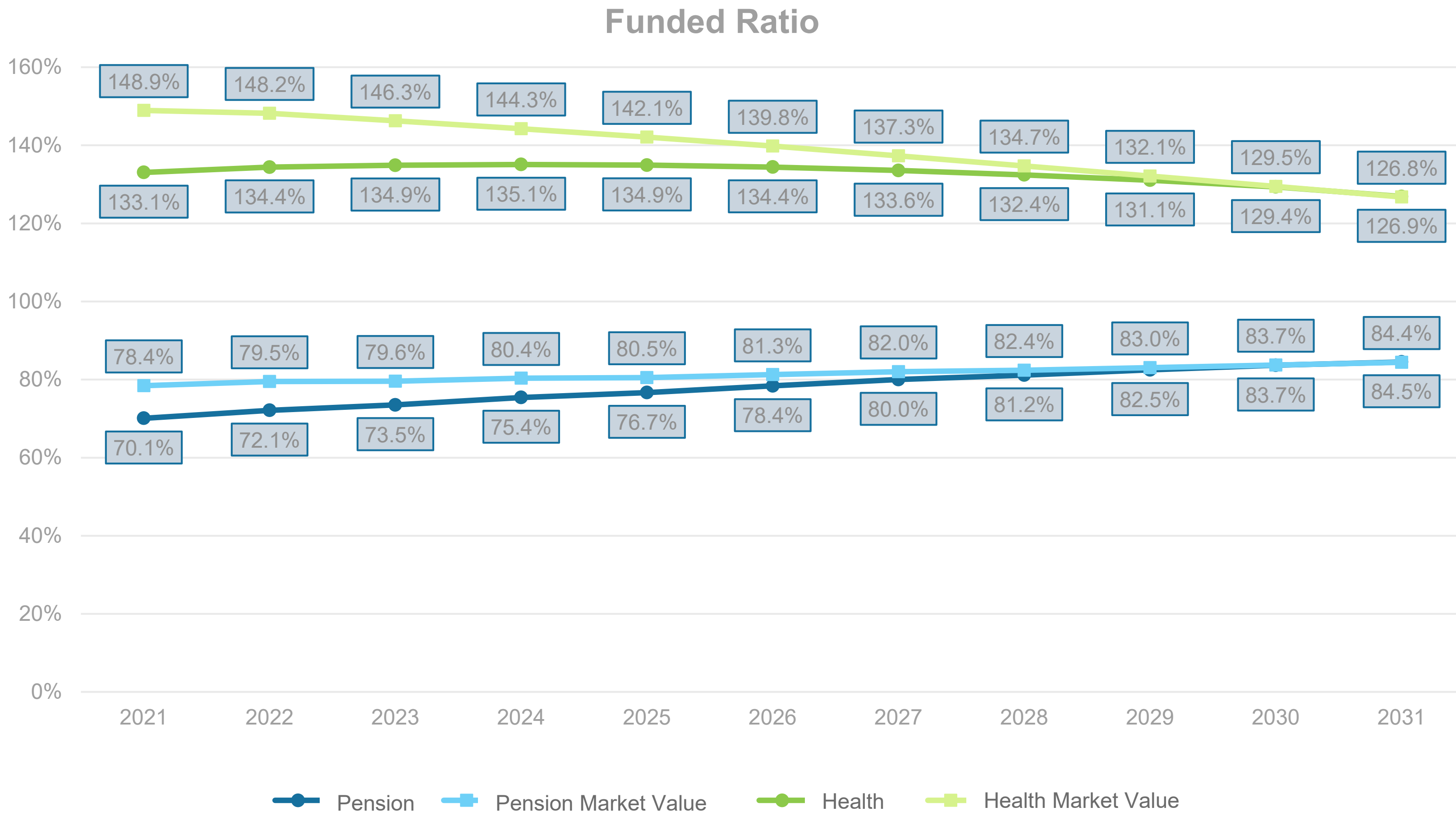


Notes: As of June 30; Assumes Current Policy allocation ASRS Alpha 10-yr expected return of 7.2% per annum

ARIZONA STATE RETIREMENT SYSTEM

10-YR FUNDED STATUS PROJECTION – PENSION

NEPC BETA RETURN ASSUMPTIONS

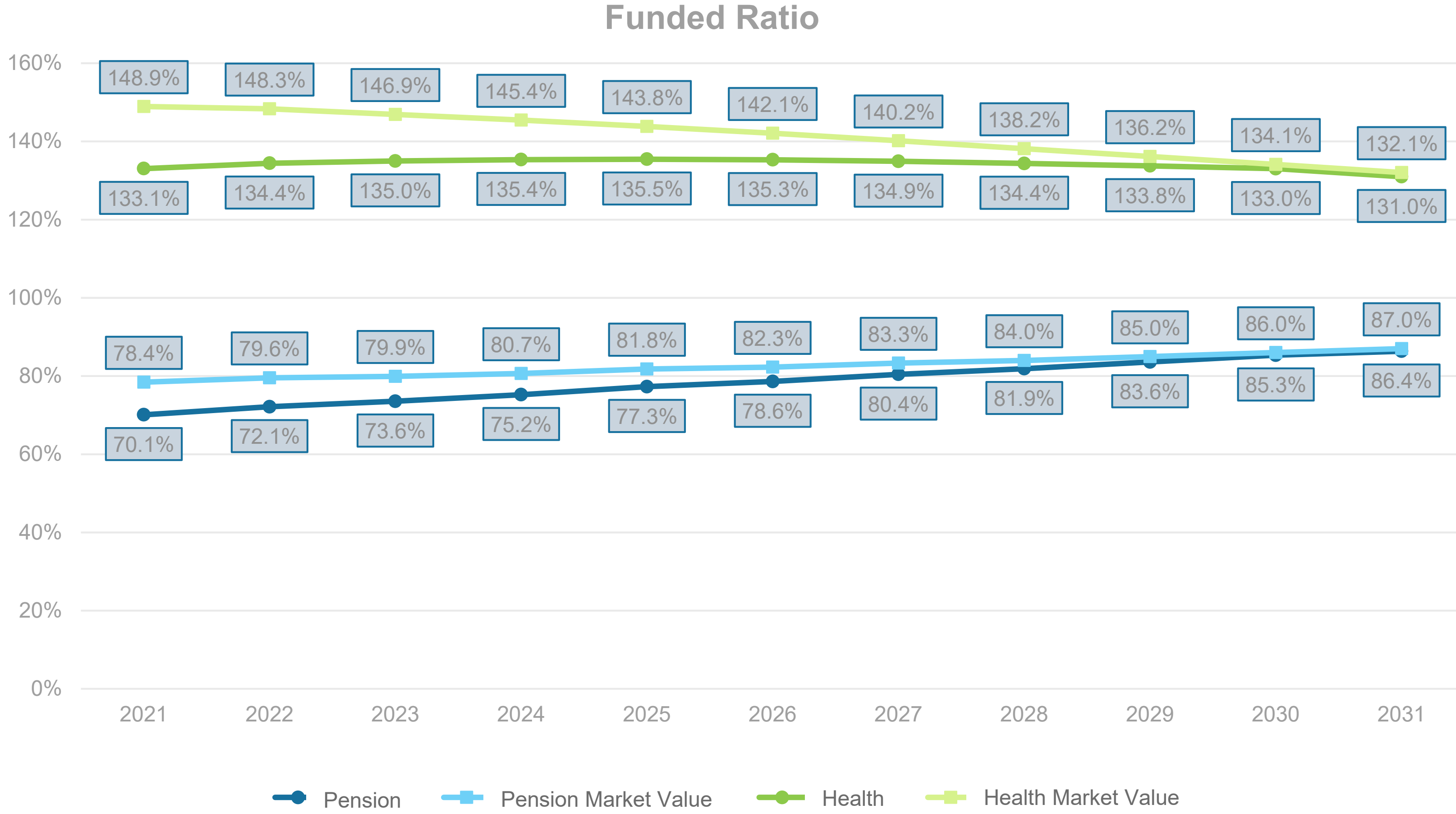


Notes: As of June 30; Assumes Current Policy allocation NEPC Beta 10-yr expected return of 6.8% per annum

ARIZONA STATE RETIREMENT SYSTEM

10-YR FUNDED STATUS PROJECTION – PENSION

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

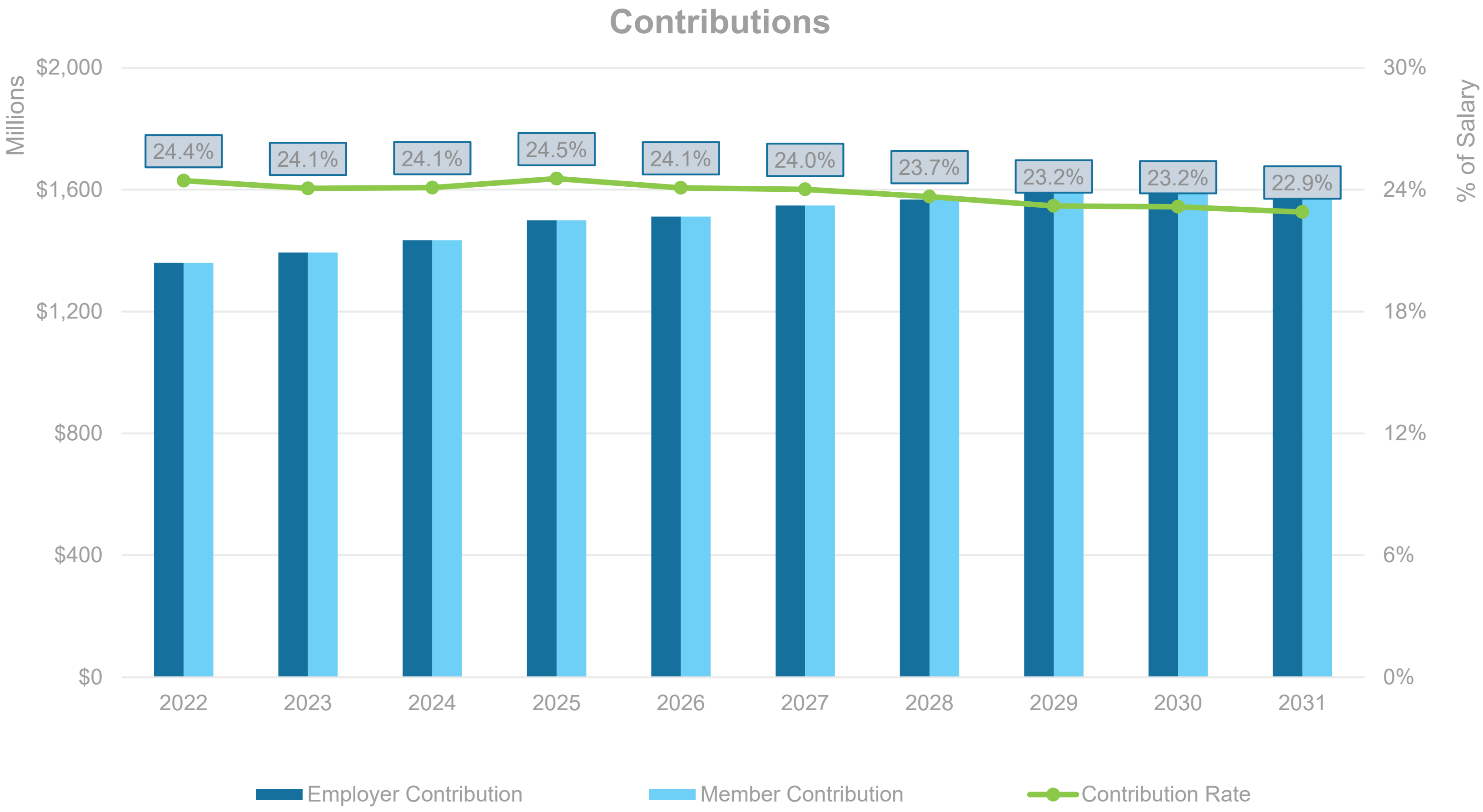


Notes: As of June 30; Assumes Current Policy allocation ASRS Alpha 10-yr expected return of 7.2% per annum

ARIZONA STATE RETIREMENT SYSTEM

10-YR CONTRIBUTION PROJECTION – PENSION & BENEFIT

NEPC BETA RETURN ASSUMPTIONS

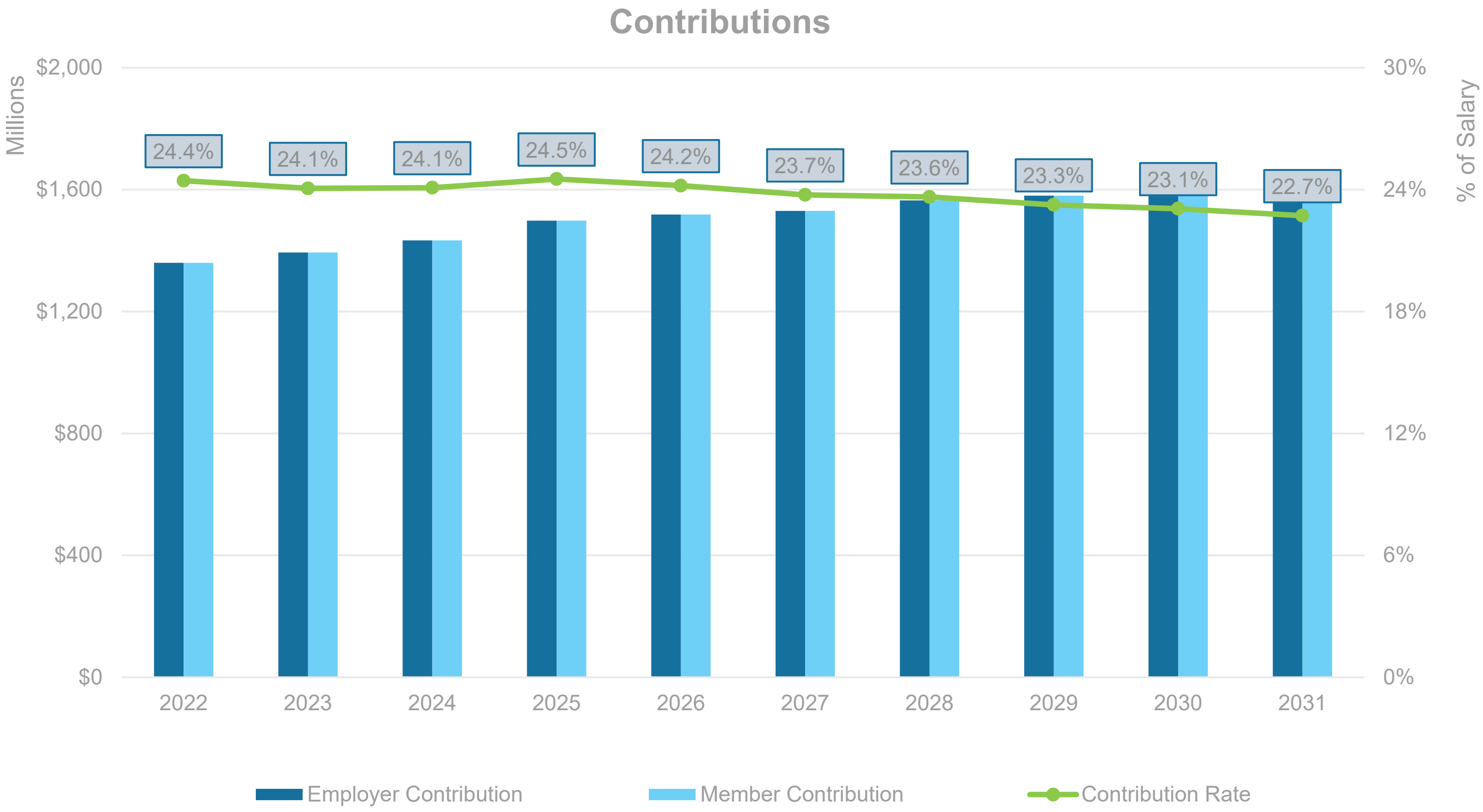


Notes: For the fiscal year ending June 30; Assumes Current Policy allocation NEPC Beta 10-yr expected return of 6.8% per annum

ARIZONA STATE RETIREMENT SYSTEM

10-YR CONTRIBUTION PROJECTION – PENSION & BENEFIT

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

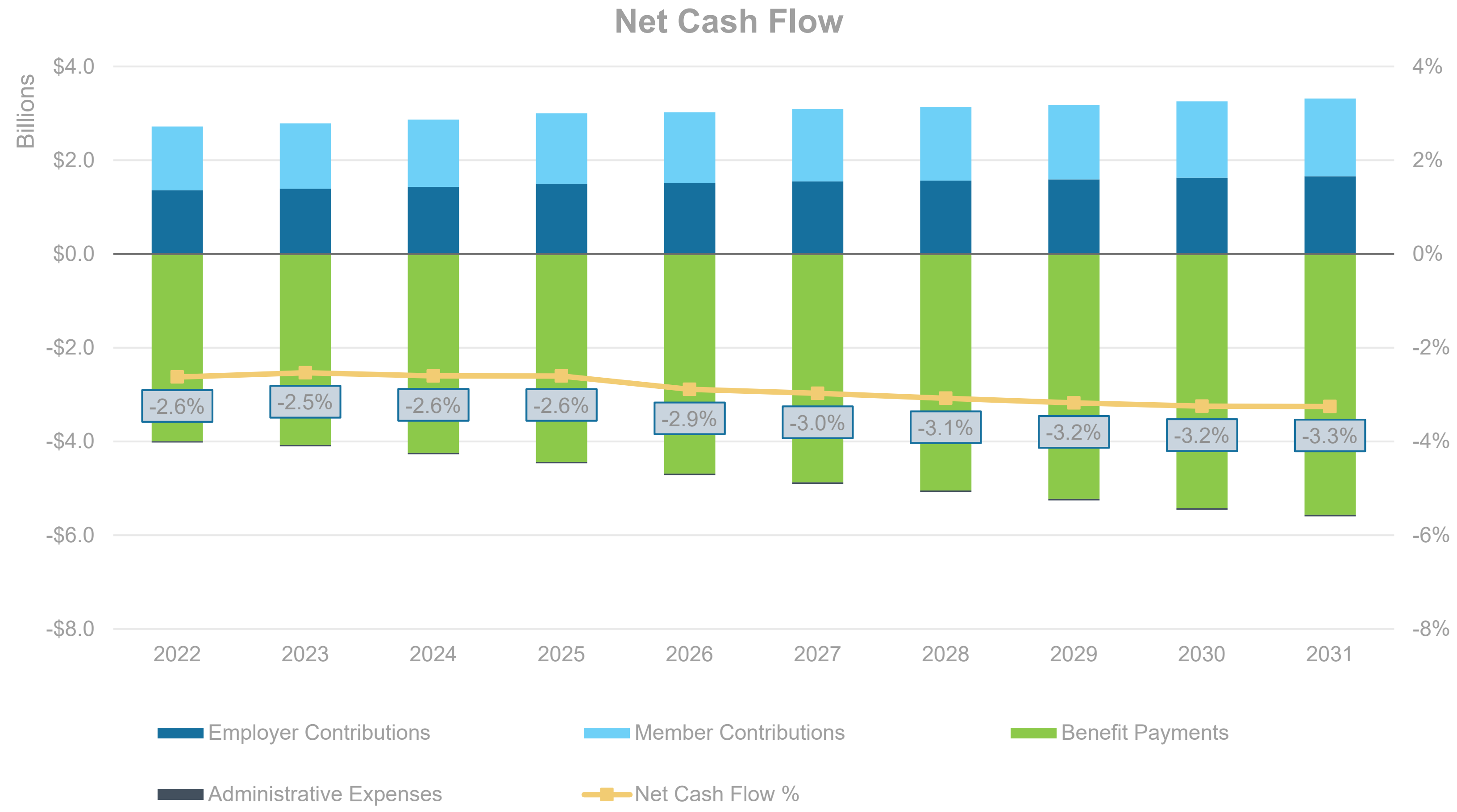


Notes: For the fiscal year ending June 30; Assumes Current Policy allocation ASRS Alpha 10-yr expected return of 7.2% per annum

ARIZONA STATE RETIREMENT SYSTEM

10-YR NET CASH FLOW – PENSION & BENEFIT

NEPC BETA RETURN ASSUMPTIONS

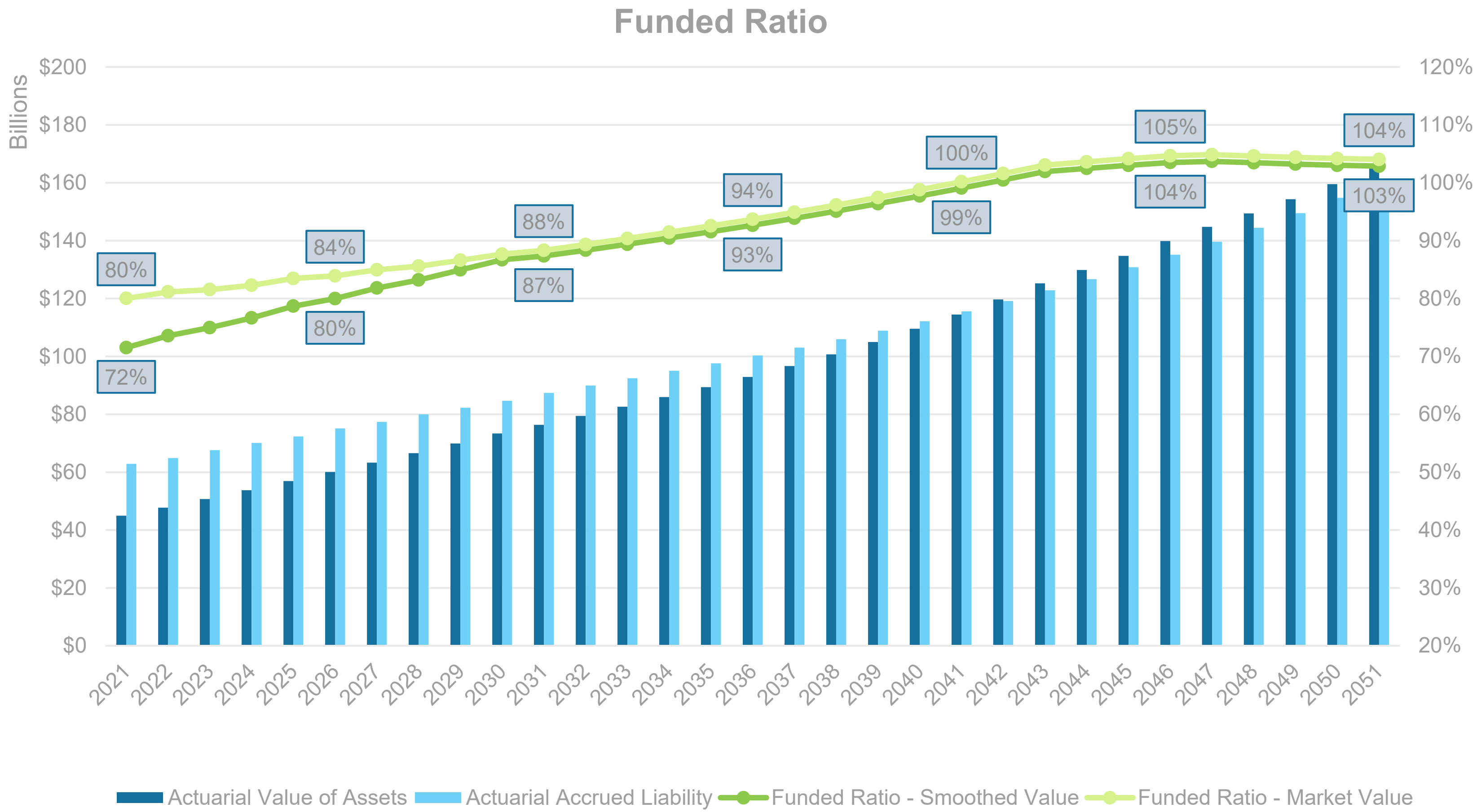


Notes: For the fiscal year ending June 30; Assumes Current Policy allocation NEPC Beta 10-yr expected return of 6.8% per annum

ARIZONA STATE RETIREMENT SYSTEM

30-YR FUNDED STATUS PROJECTION – PENSION & BENEFIT

NEPC BETA RETURN ASSUMPTIONS

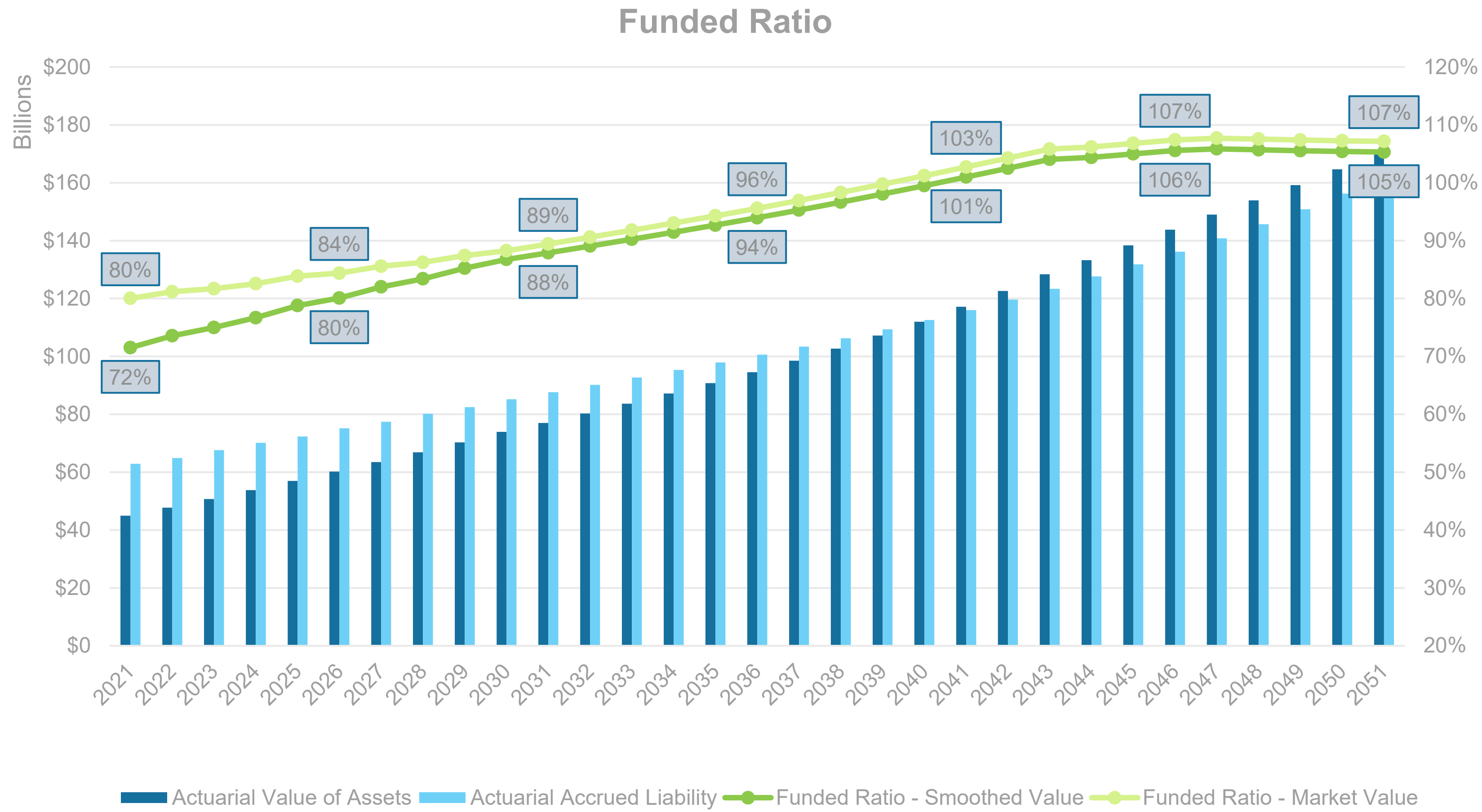


Notes: As of June 30; Assumes Current Policy allocation NEPC Beta 20-yr expected return of 7.3% per annum

ARIZONA STATE RETIREMENT SYSTEM

30-YR FUNDED STATUS PROJECTION – PENSION & BENEFIT

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

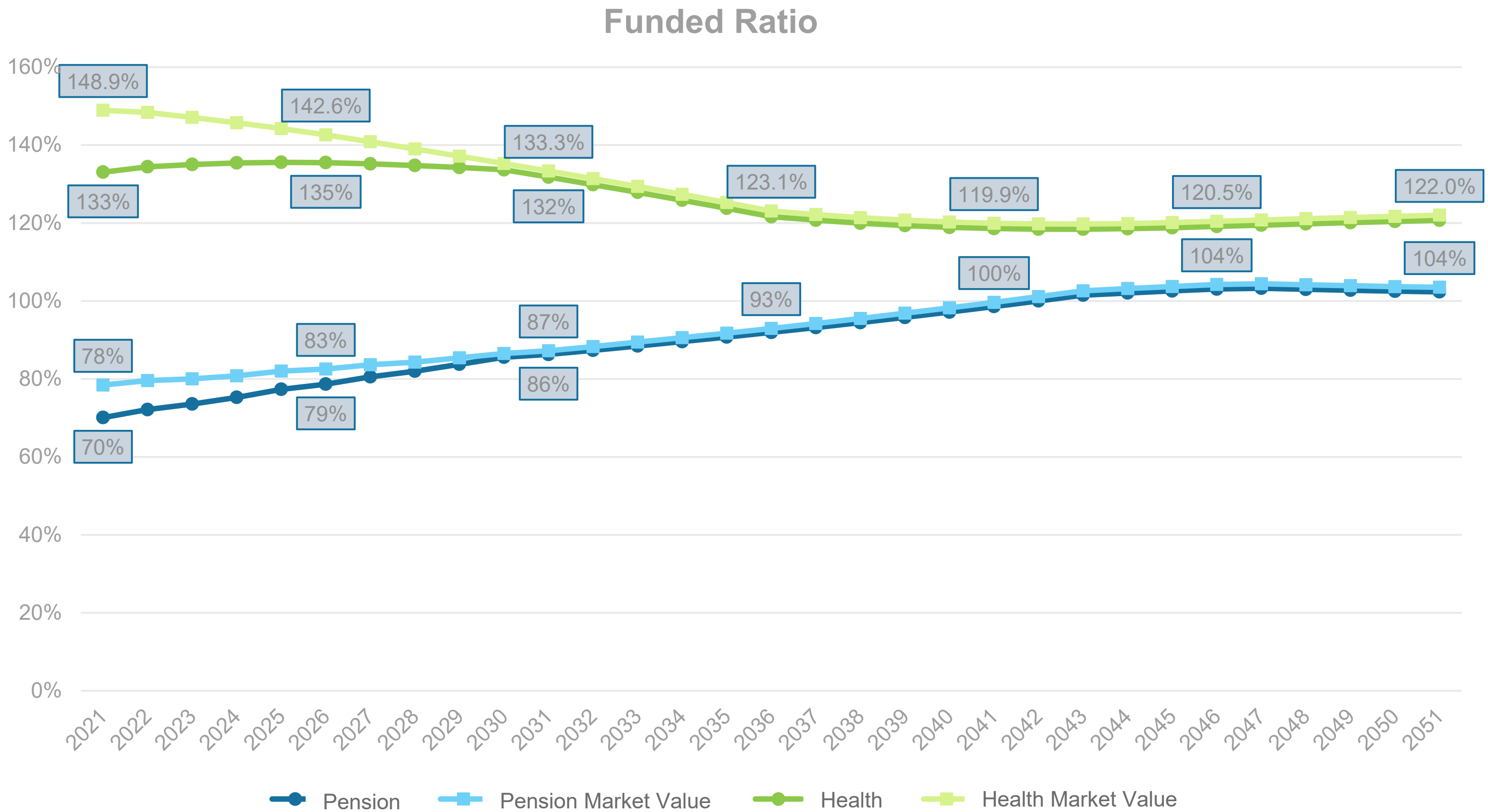


Notes: As of June 30; Assumes Current Policy allocation ASRS Alpha 20-yr expected return of 7.4% per annum

ARIZONA STATE RETIREMENT SYSTEM

30-YR FUNDED STATUS PROJECTION – PENSION

NEPC BETA RETURN ASSUMPTIONS

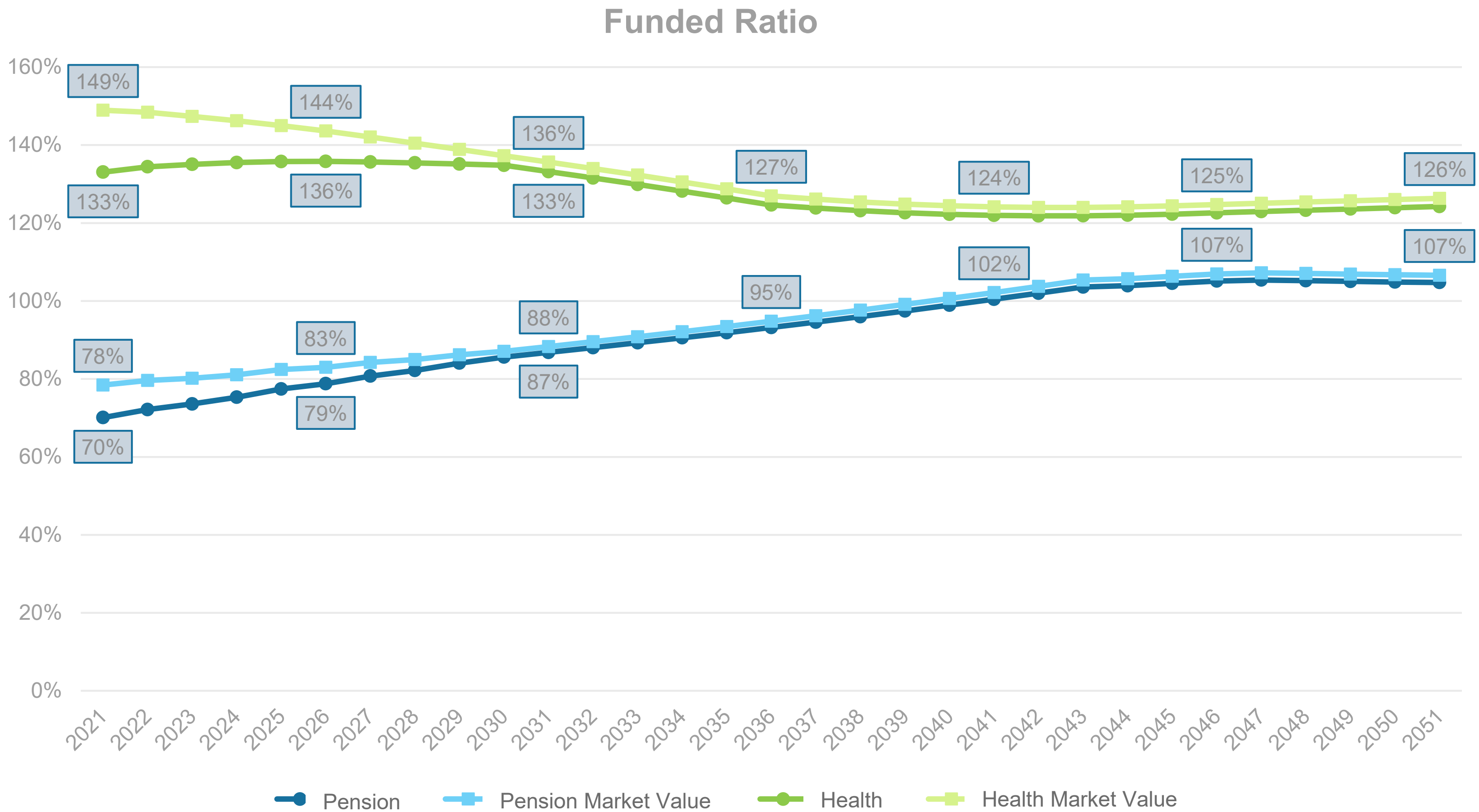


Notes: As of June 30; Assumes Current Policy allocation NEPC Beta 20-yr expected return of 7.3% per annum

ARIZONA STATE RETIREMENT SYSTEM

30-YR FUNDED STATUS PROJECTION – PENSION

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

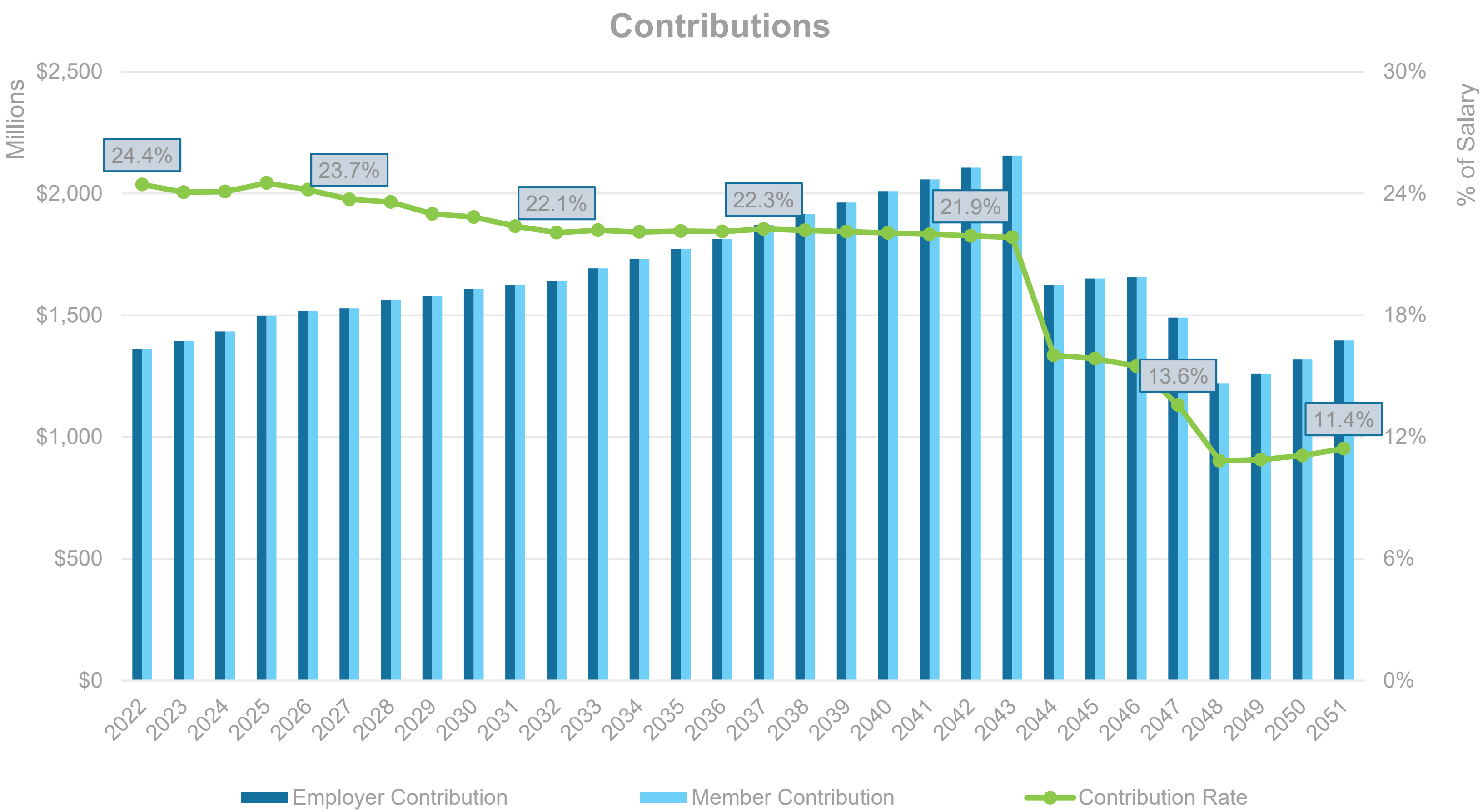


Notes: As of June 30; Assumes Current Policy allocation ASRS Alpha 20-yr expected return of 7.4% per annum

ARIZONA STATE RETIREMENT SYSTEM

30-YR CONTRIBUTION PROJECTION – PENSION & BENEFIT

NEPC BETA RETURN ASSUMPTIONS

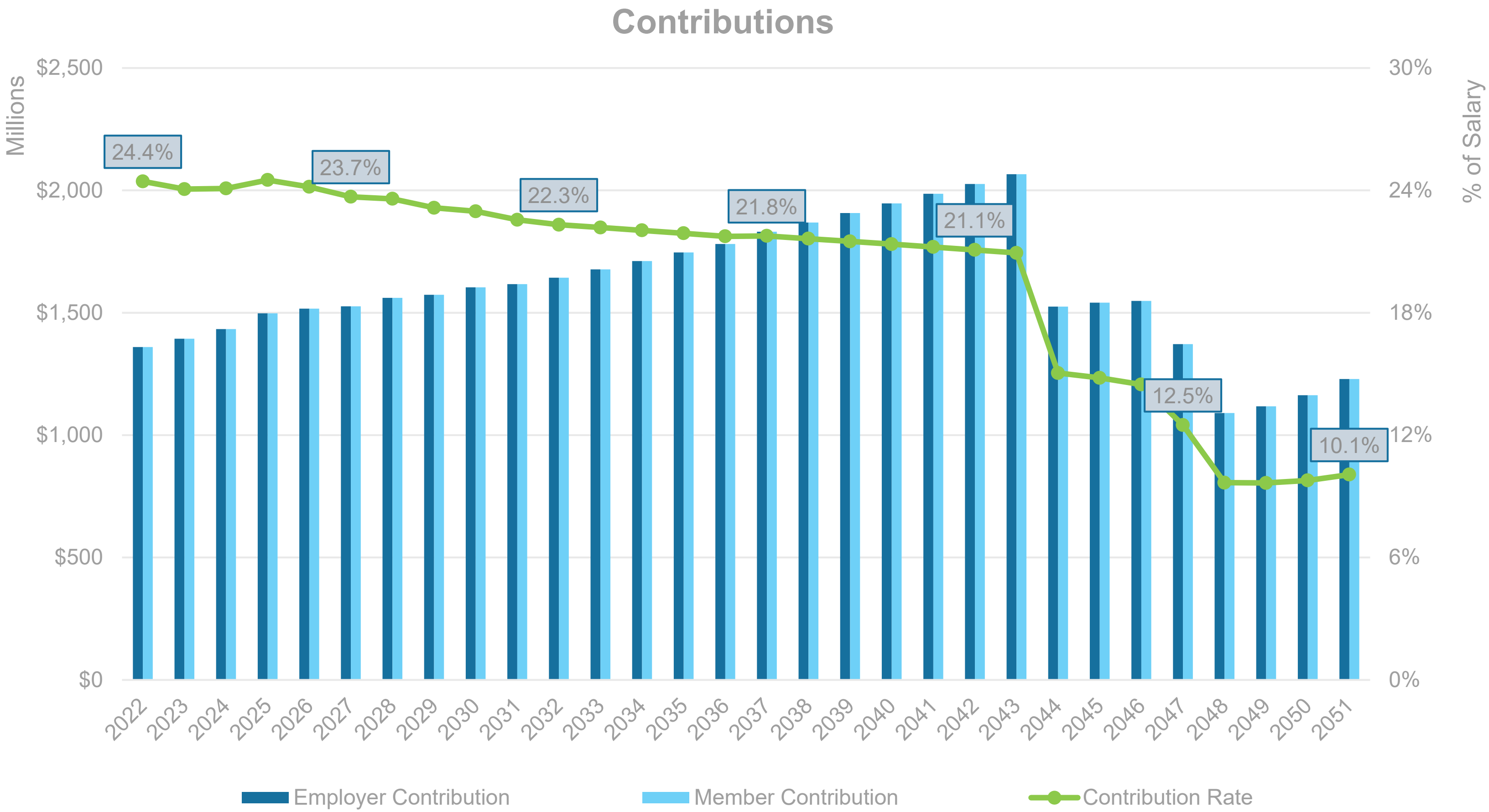


Notes: For the fiscal year ending June 30; Assumes Current Policy allocation NEPC Beta 30-yr expected return of 7.3% per annum

ARIZONA STATE RETIREMENT SYSTEM

30-YR CONTRIBUTION PROJECTION – PENSION & BENEFIT

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

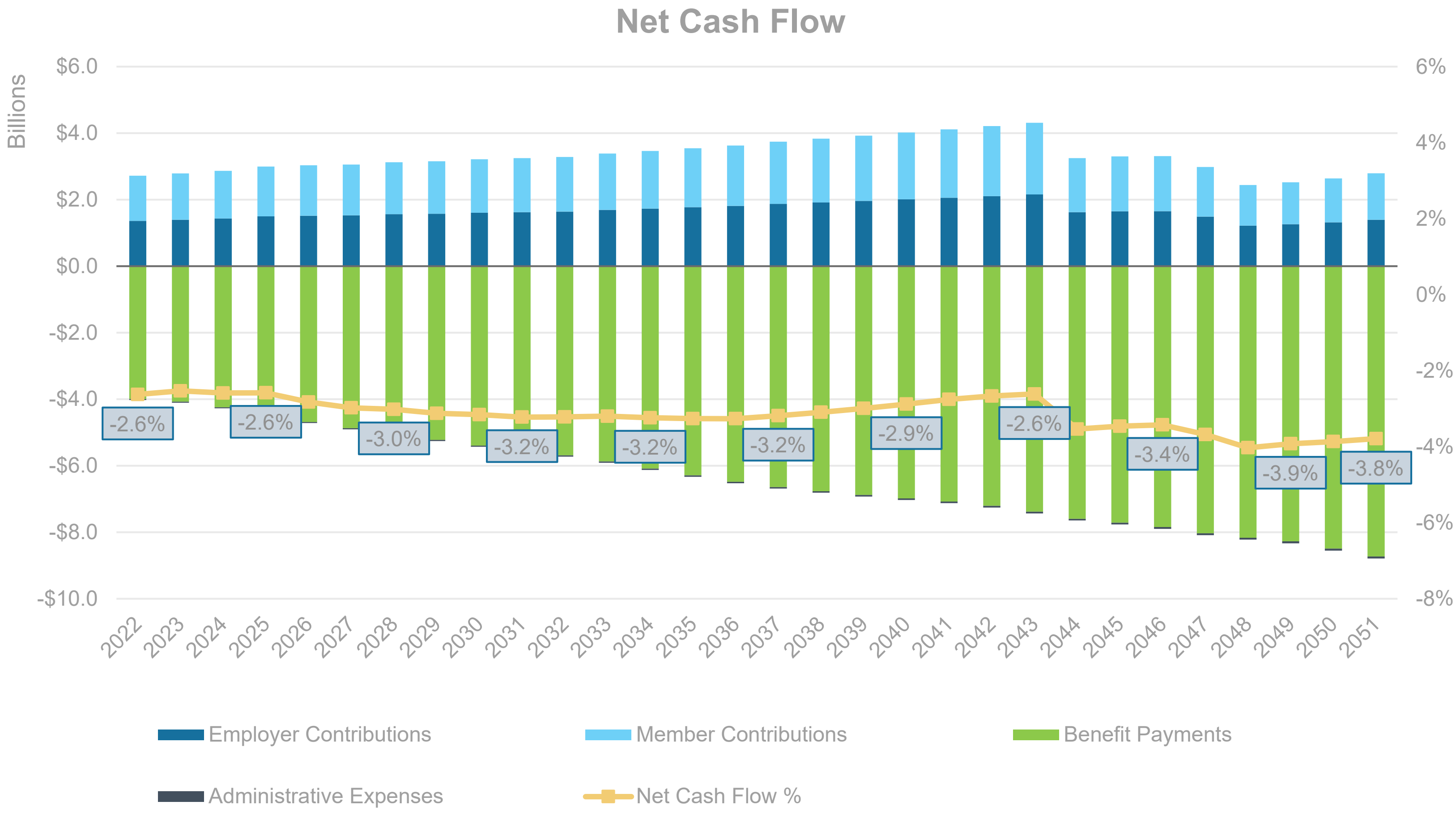


Notes: For the fiscal year ending June 30; Assumes Current Policy allocation ASRS Alpha 30-yr expected return of 7.4% per annum

ARIZONA STATE RETIREMENT SYSTEM

30-YR NET CASH FLOW – PENSION & BENEFIT

NEPC BETA RETURN ASSUMPTIONS



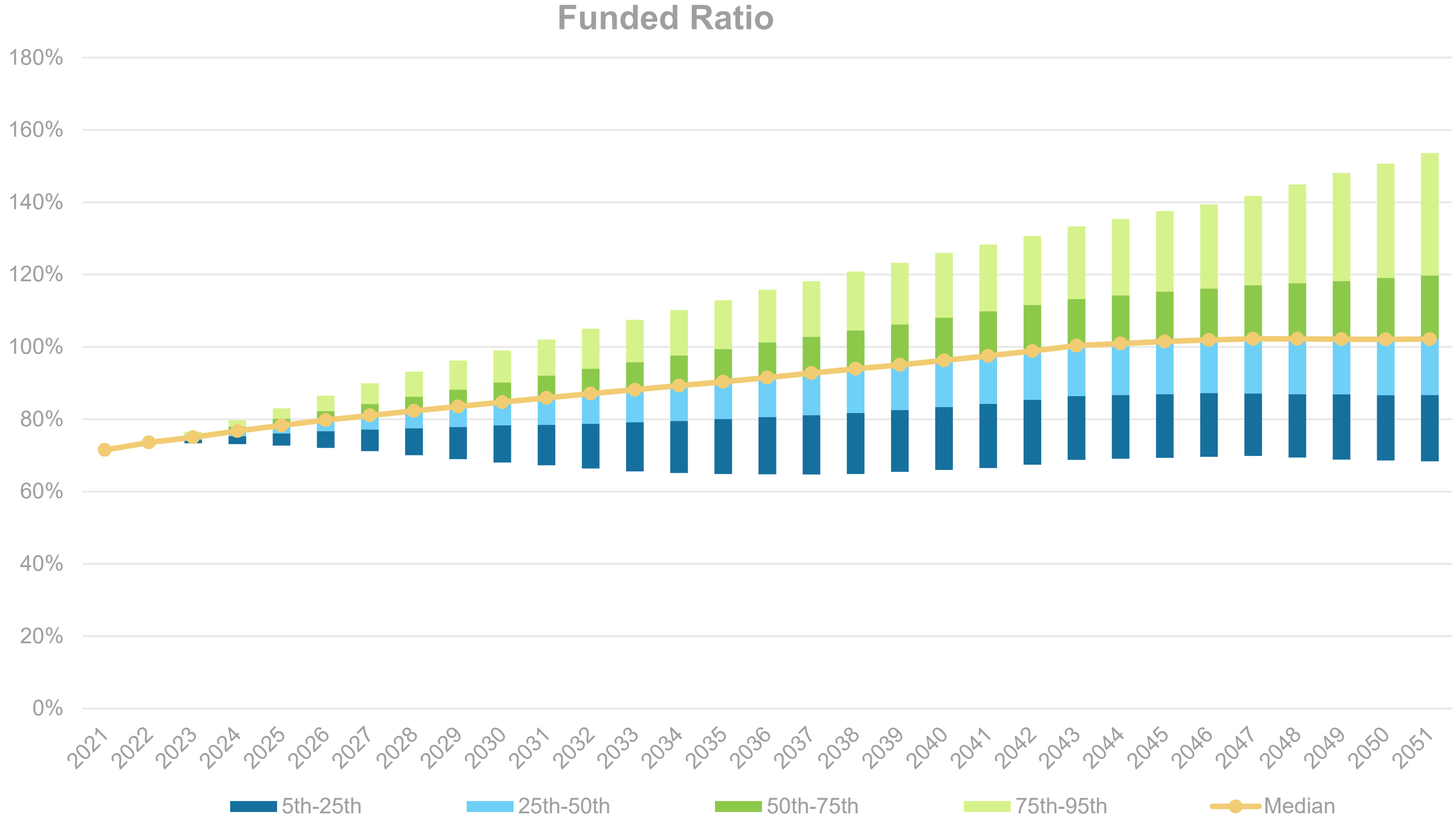
Notes: For the fiscal year ending June 30; Assumes Current Policy allocation NEPC Beta 30-yr expected return of 7.3% per annum

CURRENT POLICY STOCHASTIC PROJECTIONS

ARIZONA STATE RETIREMENT SYSTEM

STOCHASTIC FUNDED RATIO – SMOOTHED ASSET VALUES

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

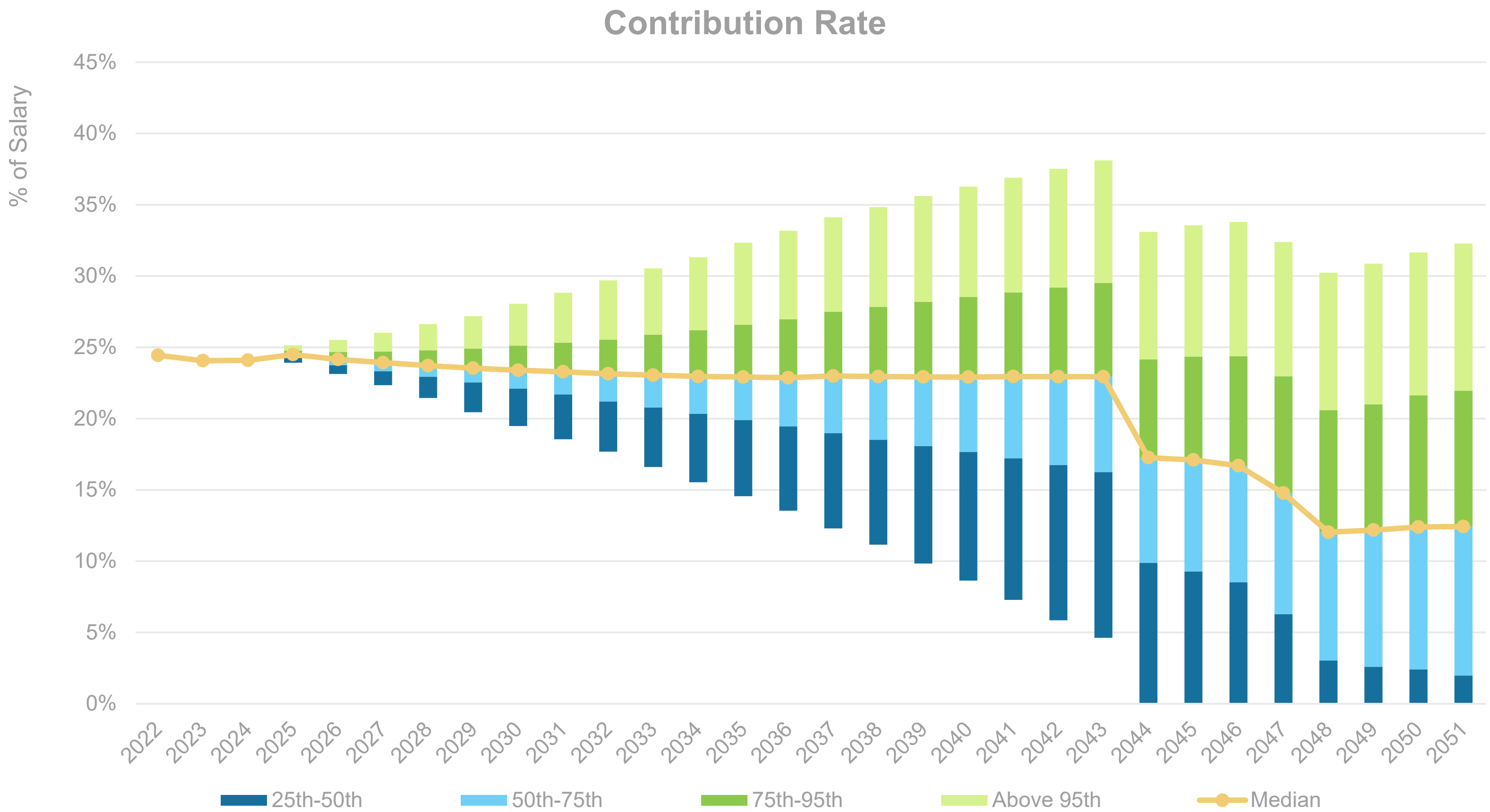


Notes: As of June 30; Assumes mean expected return equal to the ASRS Alpha 20-year expected return of 7.4% with 9.3% volatility per annum.

ARIZONA STATE RETIREMENT SYSTEM

STOCHASTIC CONTRIBUTION RATE (PENSION, HEALTH, LTD)

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS



Notes: For the fiscal year ending June 30; Assumes mean expected return equal to the ASRS Alpha 20-year expected return of 7.4% with 9.3% volatility per annum.

ALTERNATIVE ASSET ALLOCATIONS

ARIZONA STATE RETIREMENT SYSTEM

ALTERNATIVE ASSET ALLOCATIONS

NEPC BETA RETURN ASSUMPTIONS

							NEPC Beta		
Asset Class	Policy Target	Mix 2	Mix 7	Mix 10	Mix 12	Public Funds >$1B	10 Yr Return	20 Yr Return	Volatility
Public Equity	40.0%	40.0%	35.0%	44.0%	44.0%	44.0%	5.44%	6.00%	17.85%
Private Equity	10.0%	12.5%	7.0%	12.0%	10.0%	10.0%	9.24%	8.89%	11.92%
Total Equity	**50.0%**	**52.5%**	**42.0%**	**56.0%**	**54.0%**	**54.0%**	**6.24%**	**6.62%**	**16.69%**
Credit	**20.0%**	**22.5%**	**18.0%**	**22.0%**	**23.0%**	**8.0%**	**6.97%**	**8.08%**	**6.02%**
Interest Rate Sensitive	**10.0%**	**7.5%**	**5.0%**	**6.0%**	**6.0%**	**17.0%**			
US Aggregate Bond	10.0%					17.0%	**1.99%**	**2.35%**	**5.65%**
10 Yr Treasury		7.5%	5.0%	6.0%	6.0%		**1.36%**	**1.23%**	**11.64%**
Private Real Estate	**20.0%**	**17.5%**	**15.0%**	**16.0%**	**17.0%**	**8.1%**	**8.75%**	**8.75%**	**5.87%**
Public Real Assets			5.0%				**3.90%**	**5.01%**	**14.13%**
Gold			5.0%				**3.30%**	**3.77%**	**16.31%**
50% Hedge Fund-Trend Following + 50% Hedge Fund-Long Volatility			10.0%				**3.75%**	**4.70%**	**9.20%**
Multi-Asset Hedge Fund						6.8%	**4.21%**	**4.84%**	**8.64%**
Commodities						2.9%	**0.40%**	**3.30%**	**18.50%**
Global Asset Allocation						**2.5%**	**3.93%**	**4.54%**	**8.92%**
Leverage Cost							**1.85%**	**2.33%**	**0.64%**
Cash						**0.7%**	**1.47%**	**1.95%**	**0.60%**

Output	Policy Target	Mix 2	Mix 7	Mix 10	Mix 12	Public Funds >$1B
10 Yr Expected Return	6.8%	6.9%	6.4%	6.9%	6.9%	5.6%
20 Yr Expected Return	7.3%	7.4%	7.0%	7.4%	7.2%	6.2%
Standard Deviation	9.8%	9.9%	9.3%	10.5%	10.4%	10.6%
10 Yr Sharpe Ratio	0.55	0.55	0.53	0.52	0.52	0.39
20 Yr Sharpe Ratio	0.55	0.55	0.54	0.52	0.52	0.40
Probability of 1-Year Return Under 0%	24.2%	24.3%	24.6%	25.6%	25.5%	29.8%
Probability of 10-Year Return Under 0%	1.3%	1.4%	1.5%	1.9%	1.8%	4.7%
Probability of 10-Year Return Under 7%	52.3%	50.8%	58.5%	51.3%	51.6%	66.2%
Probability of 20-Year Return Under 7%	44.8%	42.6%	50.8%	43.5%	43.6%	64.1%

ARIZONA STATE RETIREMENT SYSTEM

ALTERNATIVE ASSET ALLOCATIONS

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

	ASRS Portfolio Construction								
Asset Class	Policy Target	Mix 2	Mix 7	Mix 10	Mix 12	Public Funds >$1B	10 Yr Return	20 Yr Return	Volatility
Public Equity	40.0%	40.0%	35.0%	44.0%	44.0%	44.0%	5.44%	6.00%	17.85%
Private Equity	10.0%	12.5%	7.0%	12.0%	10.0%	10.0%	9.24%	8.89%	11.92%
Total Equity	**50.0%**	**52.5%**	**42.0%**	**56.0%**	**54.0%**	**54.0%**	**6.27%**	**6.67%**	**16.57%**
Credit	**20.0%**	**22.5%**	**18.0%**	**22.0%**	**23.0%**	**8.0%**	**8.75%**	**8.75%**	**6.02%**
Interest Rate Sensitive	**10.0%**	**7.5%**	**5.0%**	**6.0%**	**6.0%**	**17.0%**			
US Aggregate Bond	10.0%					17.0%	**1.99%**	**2.35%**	**5.65%**
10 Yr Treasury		7.5%	5.0%	6.0%	6.0%		**1.36%**	**1.23%**	**11.64%**
Private Real Estate	**20.0%**	**17.5%**	**15.0%**	**16.0%**	**17.0%**	**8.1%**	**8.75%**	**8.75%**	**5.87%**
Public Real Assets			5.0%				**3.90%**	**5.01%**	**14.13%**
Gold			5.0%				**3.30%**	**3.77%**	**16.31%**
50% Hedge Fund-Trend Following + 50% Hedge Fund-Long Volatility			10.0%				**3.75%**	**4.70%**	**9.20%**
Multi-Asset Hedge Fund						6.8%	**4.21%**	**4.84%**	**8.64%**
Commodities						2.9%	**0.40%**	**3.30%**	**18.50%**
Global Asset Allocation						2.5%	**3.93%**	**4.27%**	**8.92%**
Leverage Cost							**1.85%**	**2.33%**	**0.64%**
Cash						**0.7%**	**1.47%**	**1.95%**	**0.60%**

Output	Policy Target	Mix 2	Mix 7	Mix 10	Mix 12	Public Funds >$1B
10 Yr Expected Return	7.2%	7.4%	6.7%	7.3%	7.3%	5.8%
20 Yr Expected Return	7.4%	7.5%	7.1%	7.6%	7.6%	6.3%
Standard Deviation	9.3%	9.5%	8.9%	10.1%	9.9%	10.5%
10 Yr Sharpe Ratio	0.61	0.62	0.59	0.58	0.59	0.42
20 Yr Sharpe Ratio	0.59	0.60	0.58	0.56	0.57	0.41
Probability of 1-Year Return Under 0%	22.0%	21.8%	22.6%	23.4%	23.0%	28.9%
Probability of 10-Year Return Under 0%	0.7%	0.7%	0.9%	1.1%	1.0%	4.0%
Probability of 10-Year Return Under 7%	47.3%	45.2%	54.2%	45.8%	45.8%	63.6%
Probability of 20-Year Return Under 7%	41.6%	39.0%	48.1%	39.7%	39.5%	62.0%

ARIZONA STATE RETIREMENT SYSTEM

RETURN ASSUMPTION SUMMARY

NEPC Beta

Output	Policy Target	Mix 2	Mix 7	Mix 10	Mix 12	Public Funds >$1B
10 Yr Expected Return	6.8%	6.9%	6.4%	6.9%	6.9%	5.6%
20 Yr Expected Return	7.3%	7.4%	7.0%	7.4%	7.2%	6.2%
Standard Deviation	9.8%	9.9%	9.3%	10.5%	10.4%	10.6%
10 Yr Sharpe Ratio	0.55	0.55	0.53	0.52	0.52	0.39
20 Yr Sharpe Ratio	0.55	0.55	0.54	0.52	0.52	0.40
Probability of 1-Year Return Under 0%	24.2%	24.3%	24.6%	25.6%	25.5%	29.8%
Probability of 10-Year Return Under 0%	1.3%	1.4%	1.5%	1.9%	1.8%	4.7%
Probability of 10-Year Return Under 7%	52.3%	50.8%	58.5%	51.3%	51.6%	66.2%
Probability of 20-Year Return Under 7%	44.8%	42.6%	50.8%	43.5%	43.6%	64.1%

ASRS Portfolio Construction

Output	Policy Target	Mix 2	Mix 7	Mix 10	Mix 12	Public Funds >$1B
10 Yr Expected Return	7.2%	7.4%	6.7%	7.3%	7.3%	5.8%
20 Yr Expected Return	7.4%	7.5%	7.1%	7.6%	7.6%	6.3%
Standard Deviation	9.3%	9.5%	8.9%	10.1%	9.9%	10.5%
10 Yr Sharpe Ratio	0.61	0.62	0.59	0.58	0.59	0.42
20 Yr Sharpe Ratio	0.59	0.60	0.58	0.56	0.57	0.41
Probability of 1-Year Return Under 0%	22.0%	21.8%	22.6%	23.4%	23.0%	28.9%
Probability of 10-Year Return Under 0%	0.7%	0.7%	0.9%	1.1%	1.0%	4.0%
Probability of 10-Year Return Under 7%	47.3%	45.2%	54.2%	45.8%	45.8%	63.6%
Probability of 20-Year Return Under 7%	41.6%	39.0%	48.1%	39.7%	39.5%	62.0%

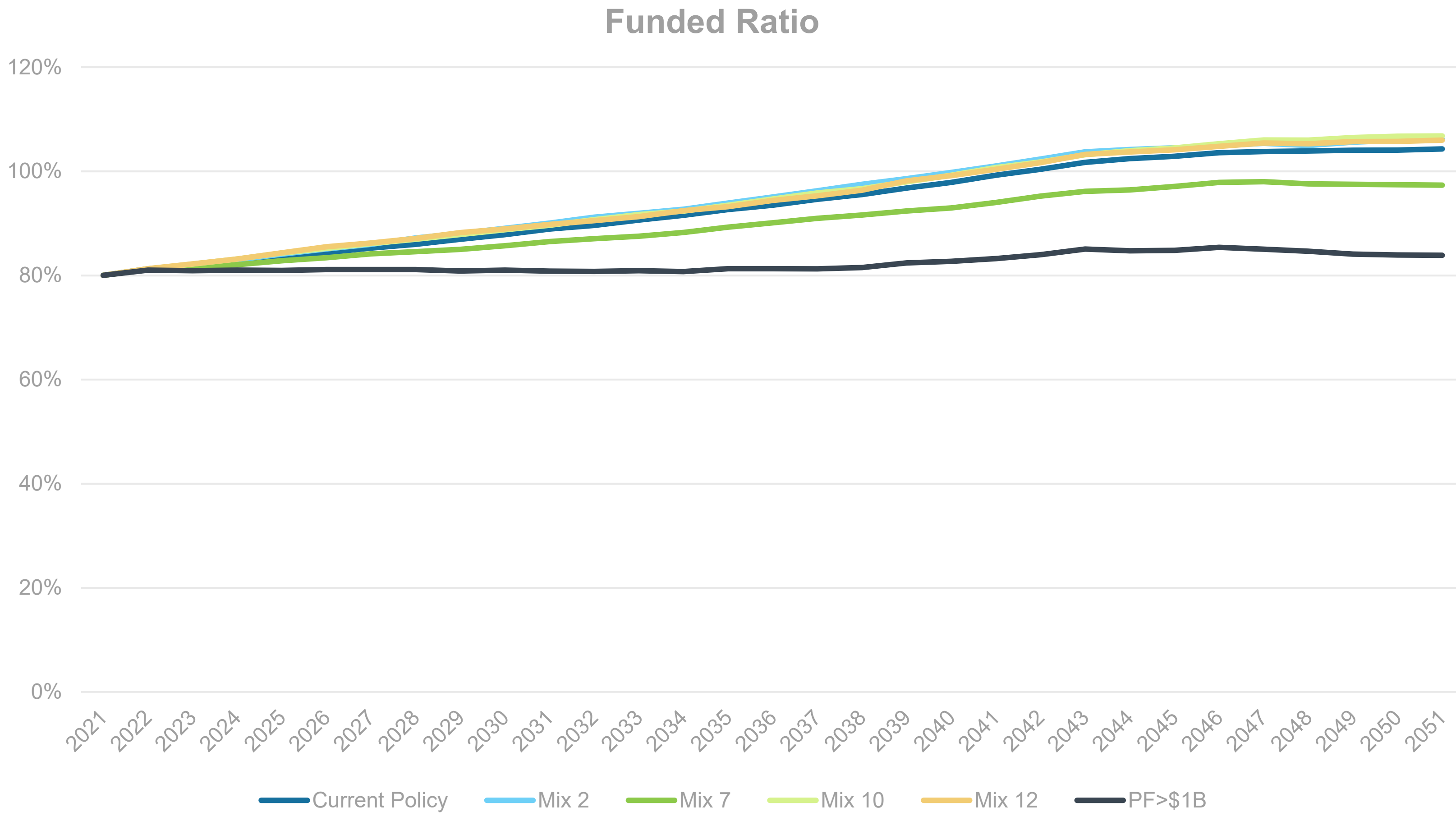
Illiquid Assets	50%	53%	50%	50%	50%	33%

Notes: Illiquid Assets includes Private Equity, Credit, Real Estate, Hedge Funds

ARIZONA STATE RETIREMENT SYSTEM

MEDIAN FUNDED STATUS – UNSMOOTHED ASSET VALUES

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

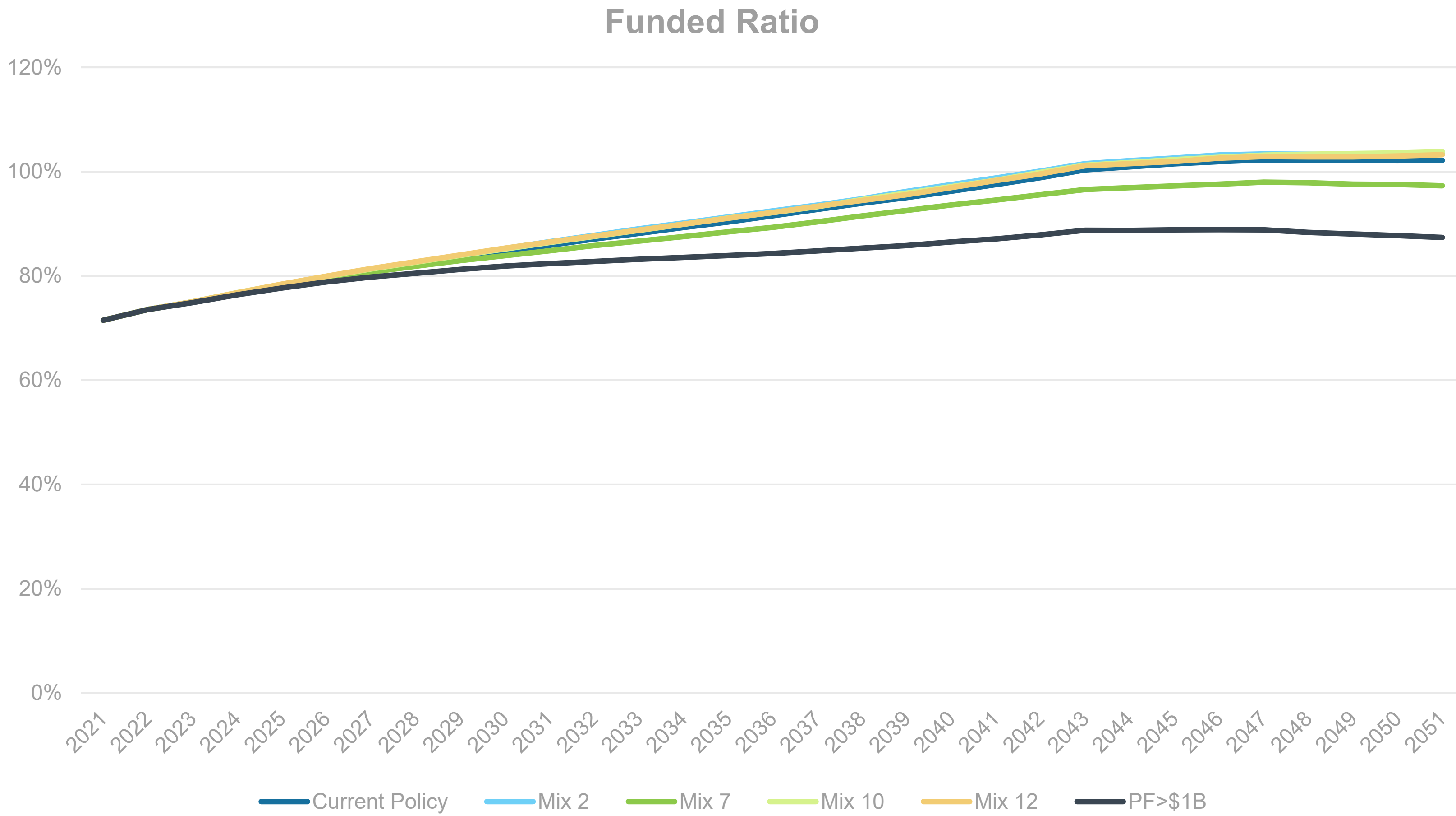


Notes: As of June 30; Assumes mean expected return equal to the ASRS Alpha 20-year expected return and volatility per annum for each mix.

ARIZONA STATE RETIREMENT SYSTEM

MEDIAN FUNDED STATUS – SMOOTHED ASSET VALUES

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS

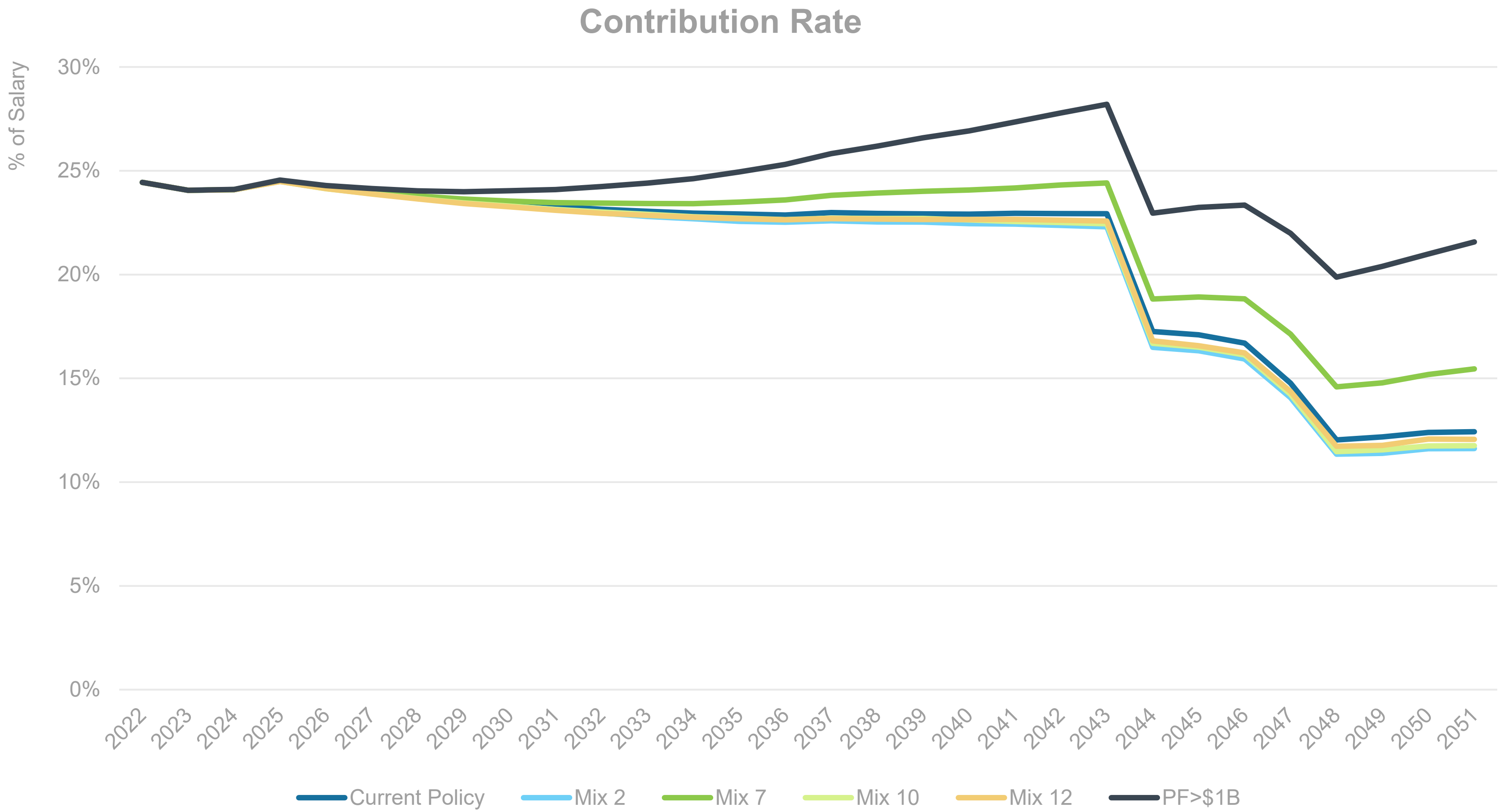


Notes: As of June 30; Assumes mean expected return equal to the ASRS Alpha 20-year expected return and volatility per annum for each mix.

ARIZONA STATE RETIREMENT SYSTEM

MEDIAN CONTRIBUTION RATE (PENSION, HEALTH, LTD)

ASRS PORTFOLIO CONSTRUCTION RETURN ASSUMPTIONS



Notes: For the fiscal year ending June 30; Assumes mean expected return equal to the ASRS Alpha 20-year expected return and volatility per annum for each mix.

ARIZONA STATE RETIREMENT SYSTEM

CONTRIBUTION RATE STATISTICS

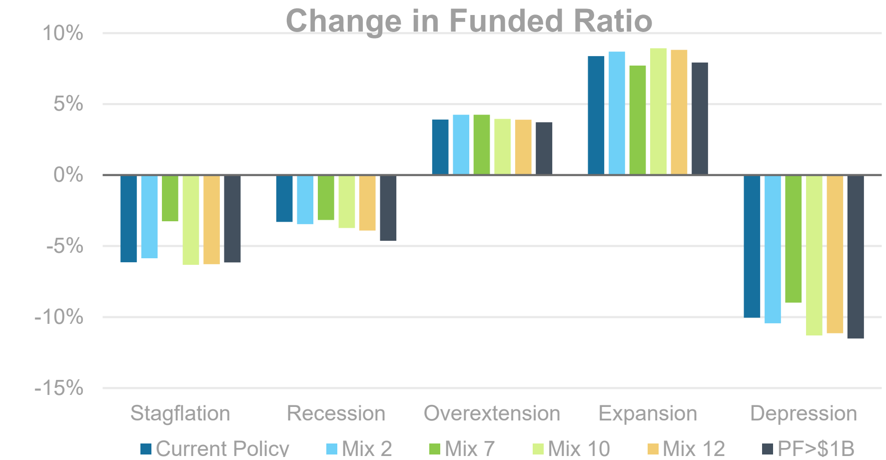
NEPC BETA RETURN ASSUMPTIONS

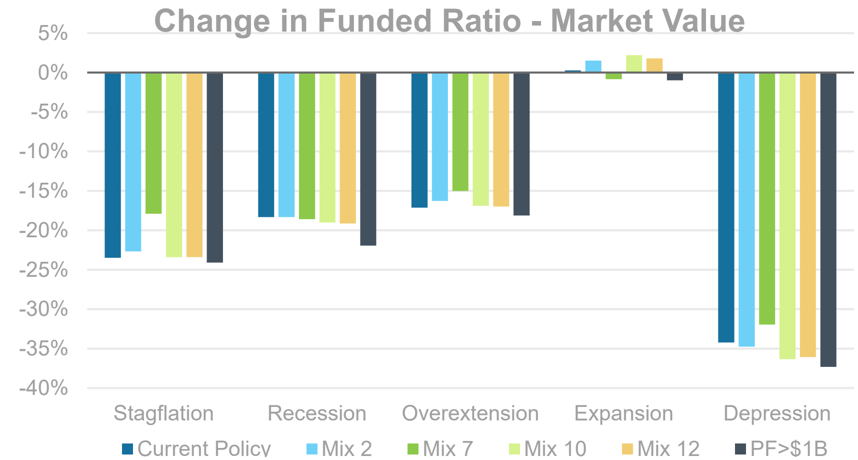
Mix	30-Yr Avg Contribution Rate	30-Yr Std Dev Contribution Rate
Current Policy	20.6%	5.5%
Mix 2	20.2%	5.7%
Mix 7	21.7%	4.9%
Mix 10	20.3%	5.8%
Mix 12	20.4%	5.7%
PF>$1B	24.3%	4.8%

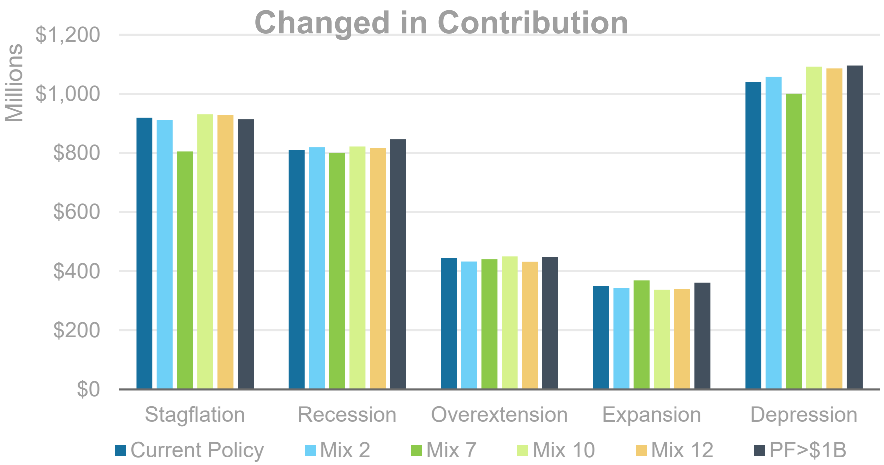
Notes: Data represents median outcomes

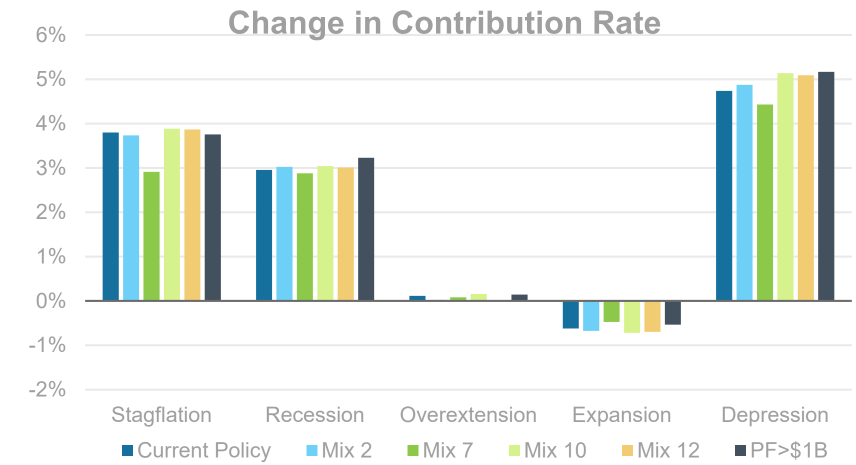
ARIZONA STATE RETIREMENT SYSTEM

SCENARIO ANALYSIS









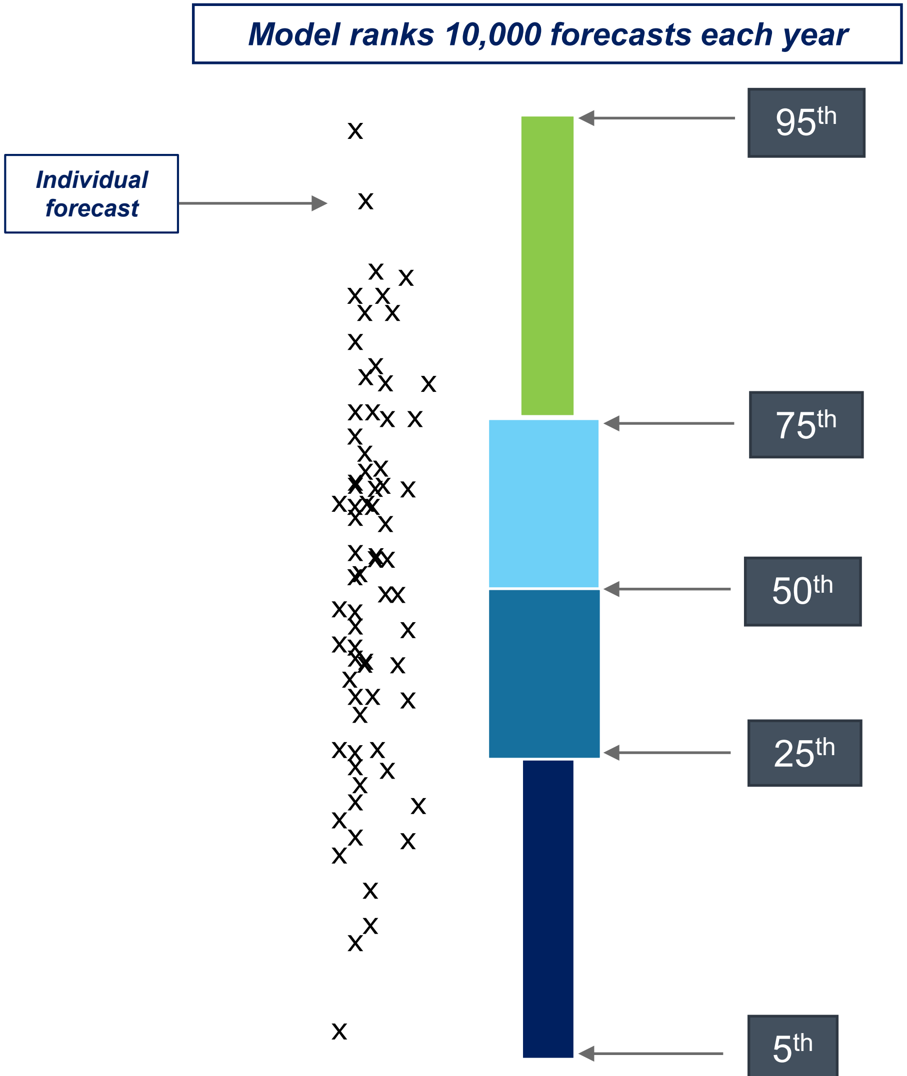
Notes: Scenarios reflect a 5-year market cycle. Change in Funded Ratio is relative to 71.5%, change in Funded Ratio – Market Value is relative to 80.0% as of June 30, 2021. Change in Contribution is relative to $2.720 million, change in Contribution Rate is relative to 24.4% for the fiscal year ending June 30, 2022.

APPENDIX

ARIZONA STATE RETIREMENT SYSTEM
ASSUMPTIONS AND METHODS

- **Deterministic and stochastic return projections are based on NEPC's 12/31/2021 capital market assumptions**
  - FYTD return of 5.5% thru 3/31/2022, thereafter NEPC's expected returns assumed
- **Asset-liability projections follow a roll-forward methodology based on the June 30, 2021 Actuarial Valuation Report**
  - Benefit payment projections provided by GRS
  - Other than those described herein, all assumptions remain unchanged from the valuation
  - No gains or losses are assumed other than those attributed to investment experience and Permanent Benefit Increases (PBI)
- **Assets, liabilities and cash flows were modeled for each individual plan and aggregated in the results noted "Pension/System Level"**
  - Individual plan results also provided for select outputs
- **Contributions based on gross normal cost-plus layered amortizations of unfunded liability**
  - Employers and Members pay an equal share of the contribution requirement

INTERPRETING STOCHASTIC RESULTS



- **95th percentile**
  - Exceeds 95% of all forecasts
  - Overly optimistic outcome
- **75th percentile**
  - Exceeds 75% of all forecasts
  - Optimistic outcome
- **50th percentile**
  - Exceeds 50% of all forecasts
  - Median outcome
- **25th percentile**
  - Exceeds 25% of all forecasts
  - Pessimistic outcome
- **5th percentile**
  - Exceeds 5% of all forecasts
  - Overly pessimistic outcome

12/31/2021 CAPITAL MARKET ASSUMPTIONS

	Asset Class	10-Year Return	30-Year Return	Standard Deviation
MACRO	Inflation	2.4%	2.6%	—
	Cash	1.5%	2.3%	0.6%
	US Leverage Cost	1.9%	2.7%	0.6%
	Non-US Cash	0.4%	1.4%	0.6%
EQUITY	US Large-Cap Equity	4.3%	6.1%	16.6%
	US Small/Mid-Cap Equity	5.6%	6.6%	20.7%
	Non-US Developed Equity	5.2%	6.2%	19.6%
	Non-US Developed Equity (USD Hedge)	5.4%	6.4%	17.6%
	Non-US Developed Small-Cap Equity	5.9%	6.8%	24.2%
	Emerging Market Equity	8.3%	8.7%	28.3%
	Emerging Market Small-Cap Equity	7.6%	8.7%	34.4%
	*Global Equity**	*5.4%*	*6.8%*	*17.9%*
	Hedge Fund – Equity	4.1%	5.2%	11.4%
	Private Equity – Buyout	7.3%	8.5%	19.0%
	Private Equity – Growth	8.6%	9.7%	31.5%
	Private Equity – Venture	10.0%	10.7%	45.0%
	Private Equity – Secondary	6.8%	7.9%	20.0%
	Non-US Private Equity	10.3%	10.7%	32.0%
	*Private Equity**	*9.0%*	*10.0%*	*25.2%*
	China Equity	8.8%	8.8%	28.6%
	US Microcap Equity	6.5%	7.5%	25.8%

12/31/2021 CAPITAL MARKET ASSUMPTIONS

	Asset Class	10-Year Return	30-Year Return	Standard Deviation
CREDIT	US TIPS	1.4%	2.6%	5.8%
	US Treasury Bond	1.5%	2.5%	5.3%
	US Corporate Bond	2.8%	4.2%	7.3%
	US Mortgage-Backed Securities	1.8%	2.8%	6.5%
	*US Aggregate Bond**	*2.0%*	*3.1%*	*5.6%*
	US High Yield Corporate Bond	3.2%	5.4%	11.2%
	US Leveraged Loan	4.7%	5.6%	9.1%
	Emerging Market External Debt	4.1%	5.1%	13.0%
	Emerging Market Local Currency Debt	5.7%	5.3%	13.0%
	Non-US Government Bond	1.1%	1.9%	9.3%
	Non-US Government Bond (USD Hedge)	1.3%	2.2%	4.0%
	*Global Government Bond**	*1.2%*	*2.2%*	*7.6%*
	*Global Government Bond (USD Hedge)**	*1.3%*	*2.3%*	*4.0%*
	Non-US Inflation-Linked Bond (USD Hedge)	0.7%	1.4%	5.9%
	*Global Multi-Sector Fixed Income**	*3.6%*	*4.8%*	*7.8%*
	*Absolute Return Fixed Income**	*2.9%*	*4.3%*	*5.8%*
	US Municipal Bond	1.6%	2.5%	6.0%
	US Municipal Bond (1-10 Year)	1.2%	2.3%	4.5%
	US High Yield Municipal Bond	2.1%	3.9%	12.0%
	Hedge Fund - Credit	4.2%	5.7%	10.2%
	Private Debt - Credit Opportunities	6.5%	7.4%	14.4%
	Private Debt – Distressed	7.2%	8.2%	14.3%
	Private Debt - Direct Lending	6.2%	7.8%	10.5%
	*Private Debt**	*6.6%*	*7.9%*	*11.6%*

12/31/2021 CAPITAL MARKET ASSUMPTIONS

	Asset Class	10-Year Return	30-Year Return	Standard Deviation
CREDIT	US Short-Term TIPS (1-3 Year)	1.2%	2.4%	3.2%
	US Short-Term Treasury Bond (1-3 Year)	1.4%	2.4%	2.1%
	US Short-Term Corporate Bond (1-3 Year)	2.3%	3.4%	3.0%
	US Short-Term High Yield Corporate Bond (1-3 Year)	2.3%	3.7%	8.5%
	US Intermediate-Term TIPS (3-10 Year)	1.5%	2.8%	5.4%
	US Intermediate-Term Treasury Bond (3-10 Year)	1.6%	2.7%	5.5%
	US Intermediate-Term Corporate Bond (3-10 Year)	3.0%	4.4%	6.5%
	US Long-Term Treasury Bond (10-30 Year)	1.3%	2.3%	10.9%
	US Long-Term TIPS (10-30 Year)	1.4%	2.4%	11.6%
	US Long-Term Corporate Bond (10-30 Year)	2.8%	4.2%	10.7%
	20+ Year US Treasury STRIPS	1.0%	2.1%	20.9%
	*US Long-Term Government/Credit**	*2.2%*	*3.4%*	*10.2%*
	US Corporate Bond - AAA	2.2%	3.3%	6.0%
	US Corporate Bond – AA	2.2%	3.4%	5.9%
	US Corporate Bond – A	2.6%	3.8%	7.2%
	US Corporate Bond – BBB	3.1%	4.4%	8.0%
	US Corporate Bond – BB	4.0%	6.0%	9.8%
	US Corporate Bond – B	3.6%	5.4%	11.7%
	US Corporate Bond - CCC/Below	-3.8%	-0.6%	20.6%
	US Securitized Bond	2.3%	3.6%	8.4%
	US Collateralized Loan Obligation	3.1%	4.0%	7.3%
	US High Yield Securitized Bond	3.4%	5.4%	11.2%
	US High Yield Collateralized Loan Obligation	5.5%	6.4%	10.8%
	US Taxable Municipal Bond	2.7%	4.3%	7.5%
	10 Year US Treasury Bond	1.8%	3.0%	7.4%
	10 Year Non-US Government Bond (USD Hedge)	0.3%	1.4%	5.1%

12/31/2021 CAPITAL MARKET ASSUMPTIONS

	Asset Class	10-Year Return	30-Year Return	Standard Deviation
REAL ASSETS	Commodity Futures	0.4%	3.3%	18.5%
	Midstream Energy	6.7%	6.7%	28.6%
	*Public Real Assets (Multi-Asset)**	*3.9%*	*5.6%*	*14.1%*
	US REIT	4.5%	6.3%	21.4%
	Global Infrastructure Equity	5.6%	6.3%	20.3%
	Global Natural Resources Equity	5.5%	6.7%	23.2%
	Gold	3.3%	4.0%	16.3%
	Core Real Estate	4.7%	5.6%	15.0%
	Non-Core Real Estate	5.9%	6.9%	17.5%
	Private Debt - Real Estate	4.6%	5.4%	11.4%
	Private Real Assets - Natural Resources	7.1%	8.2%	32.5%
	Private Real Assets – Infrastructure	5.3%	6.6%	12.6%
MULTI-ASSET	Hedge Fund – Macro	3.7%	4.9%	9.2%
	*Hedge Fund**	*4.2%*	*5.5%*	*8.6%*
	*60% S&P 500 & 40% US Aggregate Bond**	*3.7%*	*5.2%*	*10.3%*
	*60% MSCI ACWI & 40% US Aggregate Bond**	*4.4%*	*5.7%*	*11.0%*

PRIVATE MARKET COMPOSITES

Assumed public market beta composites for private market return assumptions:

Private Equity:
Private Equity – Buyout: 25% US Large Cap, 75% US Small/Mid Cap
Private Equity – Secondary: 25% US Large Cap, 75% US Small/Mid Cap
Private Equity – Growth: 50% US Small/Mid Cap, 50% US Microcap
Private Equity – Venture: 25% US Small/Mid Cap, 75% US Microcap
Private Equity – Non-US: 70% International Small Cap, 30% Emerging Small Cap
PE Composite: 34% Buyout, 34% Growth, 15 % Non-US, 8.5% Secondary, 8.5% Venture

Private Debt:
Private Debt – Direct Lending: 100% Bank Loans
Private Debt – Distressed: 20% US Small/Mid Cap, 60% US High Yield, 20% Bank Loans
Private Debt – Credit Opportunities: 24% US SMID Cap, 33% US High Yield, 33% Bank Loans
Private Debt Composite: 50% Direct Lending, 25% Credit Opportunities, 25% Distressed

Private Real Assets:
Private Real Assets – Energy: 30% Comm., 35% Midstream, 35% Public Resource Equity
Private Real Assets - Infra/Land: 30% Commodities, 70% Public Infrastructure
Private Real Estate Debt: 50% CMBS, 50% Core Real Estate

NEPC DISCLOSURES

Past performance is no guarantee of future results.

NEPC, LLC is an investment consulting firm. We provide asset-liability studies for certain clients but we do not provide actuarial services. Any projections of funded ratio or contributions contained in this report should not be used for budgeting purposes. We recommend contacting the plan's actuary to obtain budgeting estimates.

The goal of this report is to provide a basis for substantiating asset allocation recommendations. The opinions presented herein represent the good faith views of NEPC as of the date of this report and are subject to change at any time.

Information on market indices was provided by sources external to NEPC. While NEPC has exercised reasonable professional care in preparing this report, we cannot guarantee the accuracy of all source information contained within.

The projection of liabilities in this report uses standard actuarial projection methods and does not rely on actual participant data. Asset and liability information was received from the plan's actuary, and other projection assumptions are stated in the report.

All investments carry some level of risk. Diversification and other asset allocation techniques do not ensure profit or protect against losses.

This report is provided as a management aid for the client's internal use only. This report may contain confidential or proprietary information and may not be copied or redistributed to any party not legally entitled to receive it.