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## Introduction

RVK, Inc. (RVK) has prepared this report for the City of Austin Employees' Retirement System (COAERS) to:

- Present projected valuation results with respect to the funded status of the System.
- Present projected benefit payments of the System.
- Investigate asset mixes to determine those which best serve to protect and increase funding levels, while providing adequate liquidity for benefit payments.

The valuation projections are shown using both a deterministic and stochastic process.

The deterministic process provides an open group analysis of projected valuation results based on a fixed set of future assumptions (see summary in the Assumptions and Methods section of this report).

The stochastic process provides an open group analysis of projected valuation results under many capital market environments based on expected asset returns and inflation, and their expected volatility. Using a Monte Carlo simulation technique, both assets and liabilities are assumed to vary stochastically, linked together by changes in inflation. Expected values, variances of the returns and inflation, and correlations are used to generate 2,000 trials to produce a distribution of potential outcomes. A stochastic analysis can answer questions about the best/worst case outcomes along with the probability of such outcomes.

## **Introduction** (continued)

**What is an Asset/Liability Study?**

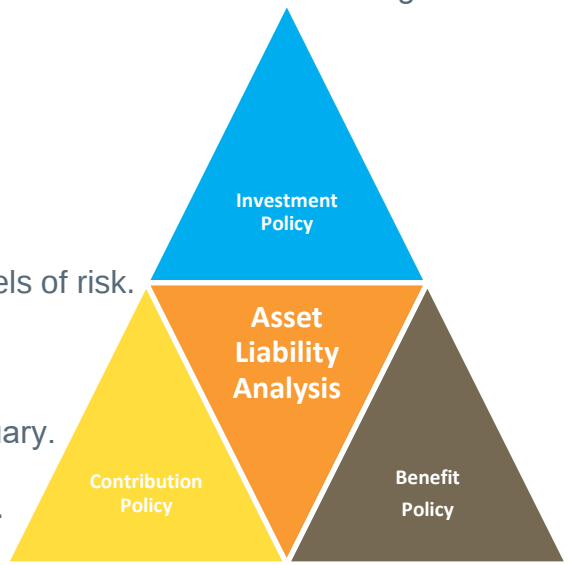
- Investment programs and the strategy they seek to implement (Investment Policy) do not exist in a vacuum. They seek to satisfy one or more investment objectives and operate within a system framework that includes the investment objectives (Benefit Policy) and system funding (Contribution Policy).

- The purpose of an Asset/Liability Study is to examine how well alternative investment strategies (i.e., differing asset allocations) address the objectives served by the System (the System's "liabilities") in the context of the System's funding streams (the System's Contribution Policy). It is the only standard analysis that fully links all three aspects of the System's key financial drivers.

- In doing so, it creates an important "guidepost" for the actual asset allocation for the System; the asset allocation chosen by the System's fiduciaries will likely reflect the nature of the liabilities but also numerous other factors including risk preferences, liquidity, implementation constraints, etc.

- For the COAERS Asset/Liability Study, we assume the objectives are:

    1. Fund all participants' benefits over time.
    2. Assure sufficient liquidity to pay benefits at all times.
    3. Foster a stable contribution stream consistent with objectives 1 and 2.
    4. Achieve adequate returns without accepting unnecessary or imprudent levels of risk.




**An Asset/Liability Study is NOT . . .**

- An actuarial study of the COAERS liabilities—that is the purview of the System's actuary.

- A prescription for System benefits—that is the purview of the elected representatives.

- An assessment of the affordability of contribution levels—that is the purview of the elected officials and their constituents.

- The sole determinant of the final asset allocation adopted for the System—there are a number of factors, including insights from an Asset/Liability Study, which will bear on the optimal asset allocation.



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## **Introduction** (continued)

### Asset/Liability Studies in Practice . . .

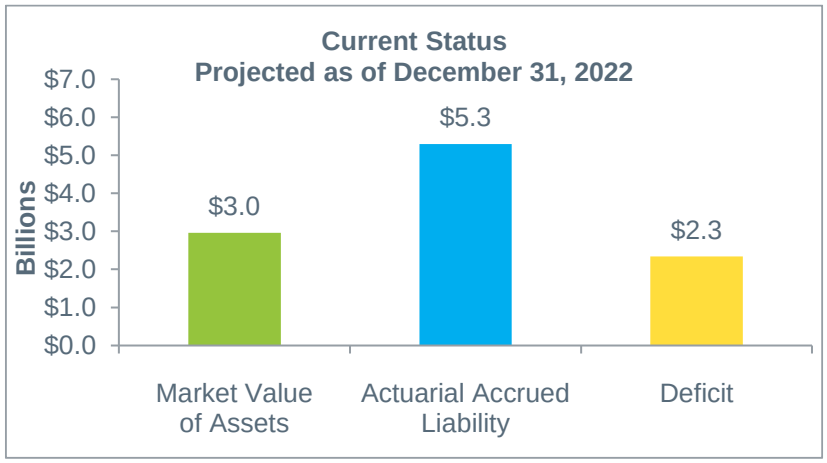
- Begin with a forecast of the financial liabilities (i.e., benefit obligations).
- Include a baseline estimation of the financial contributions to the System over time.
- Compare alternative investment strategies (i.e., total fund asset allocations to the System's financial needs).
- Draw conclusions regarding how well various investment strategies satisfy the System's financial needs.

### This Asset/Liability Study . . .

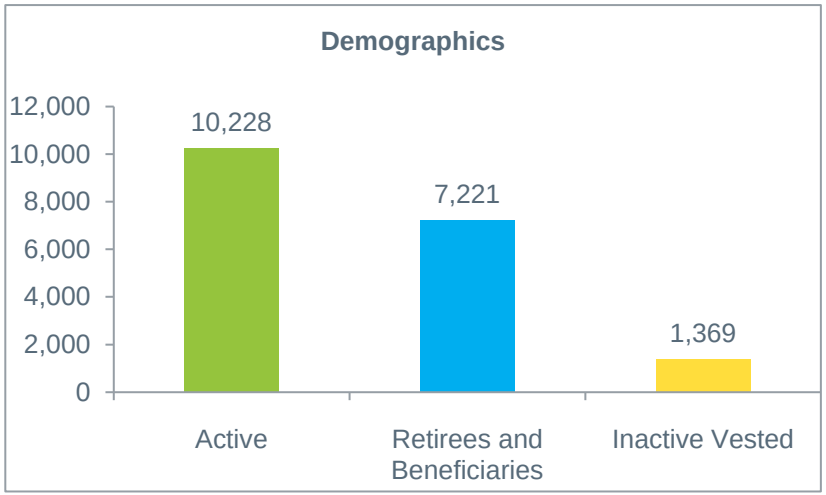
- Uses data from the December 31, 2021 Actuarial Valuation of the City of Austin Employees' Retirement System (COAERS) provided by GRS to project pension liabilities over a 20 year period.
- Uses the actuarial cost method and the actuarial assumptions described in the December 31, 2021 Actuarial Valuation prepared by GRS.
- Compares these specific investment strategies—(A) the current Target Allocation, (B) a conservative illustrative portfolio (100% Fixed Income), (C) a 60/40 portfolio, (D) a potential target, (E) a diversified portfolio with private credit and private equity, and (F) an aggressive illustrative portfolio (100% Equity).
- Assumes the System's current benefit policy throughout the entire projection period—changes to the benefit policy are the purview of the elected representatives.
- Compares the System's current funding policy with expected statutory changes beginning with the 2024 plan year.
- Does not assume any actuarial or investment adjustments that may take place in future years.

# Current Status

| System Summary | December 31, 2021 (Valuation Date) | December 31, 2022 Projection* |
|---|---|---|
| **Market Value of Assets** | $3.6 billion | $3.0 billion |
| **Actuarial Accrued Liability** | $5.0 billion | $5.3 billion |
| **Deficit** | $1.5 billion | $2.3 billion |
| **Market Value Funded Ratio** | 71% | 56% |




| Demographics | Members (Valuation Date) |
|---|---|
| **Active Members** | 10,228 |
| **Retirees and Beneficiaries** | 7,221 |
| **Inactive Vested** | 1,369 |
| **Total** | **18,818** |




*Based on a 2022 total portfolio return of -15.6%.



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## Deterministic Analysis

This section provides an analysis of the System's assets, liabilities, funded status, and benefit payments based on a fixed set of future assumptions. Each analysis that follows in this deterministic section rests on the critical assumptions below and must be read and interpreted with them in mind. The deterministic assumptions are as follows:

1. Current System provisions (see Summary of Benefit Provisions in Section F of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS).

2. The participant data used in the COAERS December 31, 2021 Actuarial Valuation prepared by GRS.

3. Projected rate of return on System assets -15.6% for 2022. Thereafter, assumes the actuarial assumed rate of return on System assets of 6.75%.

4. Employer and Employee contributions in all years are assumed to be:

    - Employer – Normal cost, plus amortization of unfunded liabilities, subject to corridor restrictions with 2-year phase-in.
    - Employee – For 2022 and 2023: 8.0%,.2024: 9.0%, 2025 and thereafter: 10.0% of projected payroll. Additional employee contributions of up to 2.0% are required beginning in 2024 under certain corridor measurements.

5. Asset Valuation Method equal to the market value of assets less a five-year phase in of the excess (shortfall) between expected investment return and actual income.

6. Assumes demographic experience projected in accordance with the assumptions used in the COAERS December 31, 2021 Actuarial Valuation prepared by GRS, and updates from the Risk Sharing Valuation Study as of December 31, 2022.

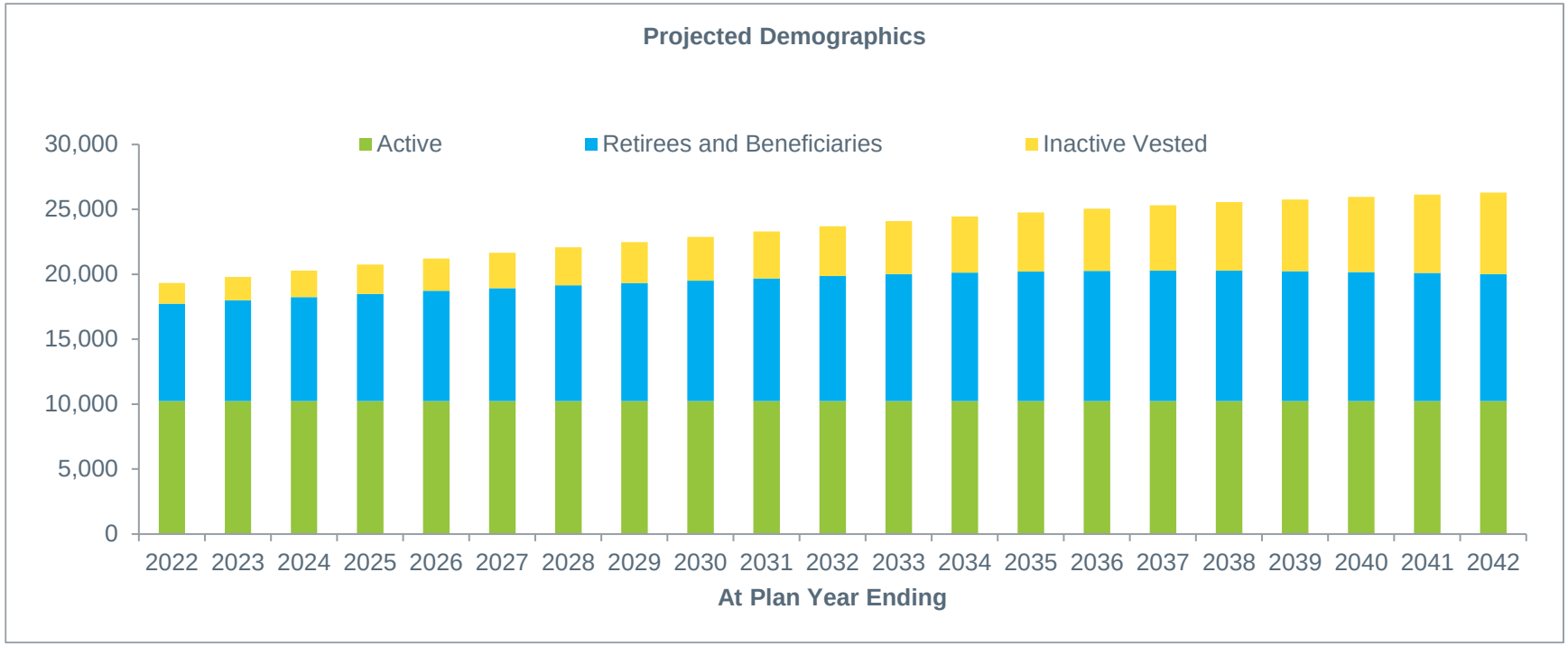
7. Assumes 4.5% base wage inflation for 2022, and 2.50% thereafter.

8. Open group analysis: level active population. New active participants entering the System are assumed to have the age, pay, and gender characteristics of recently hired participants.

# **Deterministic Analysis** (continued)

## Demographics

Following is the projected number of active and inactive participants at the end of each System year from 2021 through 2042 (2021 is actual). These projections are based on an open group analysis assuming a level active member population. Using the actuary's assumptions for death, termination, retirement, and disability, current participants are assumed to leave the System in the future. The number of total inactive participants (Retirees and Beneficiaries and Vested Inactive) increases by approximately 50% during the projection period.




| Total Population Annual Percent Change | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% |



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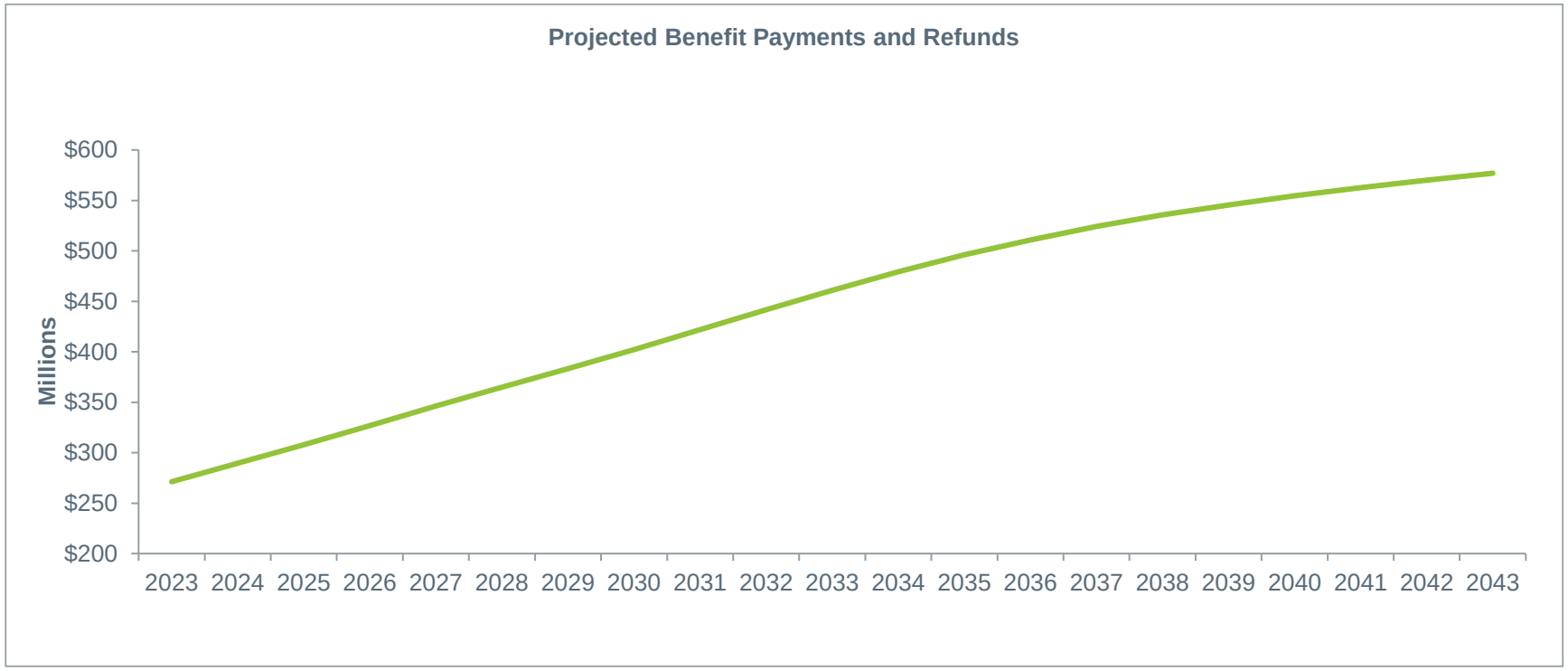
# **Deterministic Analysis** (continued)

## Benefit Payments and Refunds

The System's projected annual benefit payments are shown in the chart below. The projected benefit payments are expected to increase by about 114% over the projection period.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Benefit Payments** | $271 | $290 | $308 | $327 | $346 | $365 | $383 | $402 | $422 | $442 | $461 | $479 | $496 | $511 | $524 | $536 | $546 | $555 | $563 | $570 | $577 |



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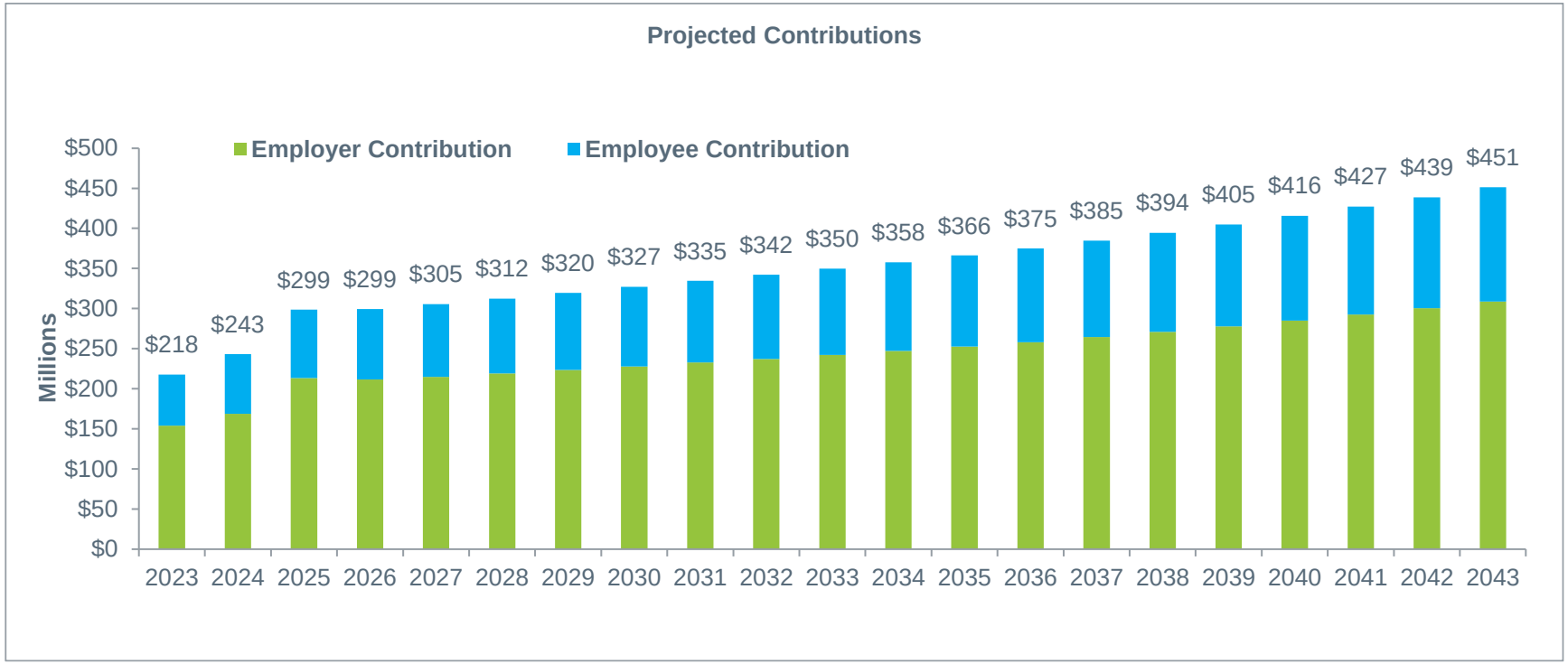
# **Deterministic Analysis** (continued)

## Contributions ($)

The System's projected contributions, expressed as total dollar contributions, are shown in the chart below. The results assume the contribution policy remains unchanged, and that the System's assets return precisely the actuarially assumed rate each year without exception for all projection years.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Employer** | $154 | $169 | $213 | $211 | $215 | $219 | $223 | $228 | $233 | $237 | $242 | $247 | $252 | $258 | $264 | $271 | $278 | $285 | $293 | $301 | $309 |
| **Employee** | $64 | $74 | $85 | $88 | $91 | $93 | $96 | $99 | $102 | $105 | $108 | $111 | $114 | $117 | $120 | $124 | $127 | $131 | $134 | $138 | $142 |
| **Total** | $218 | $243 | $299 | $299 | $305 | $312 | $320 | $327 | $335 | $342 | $350 | $358 | $366 | $375 | $385 | $394 | $405 | $416 | $427 | $439 | $451 |



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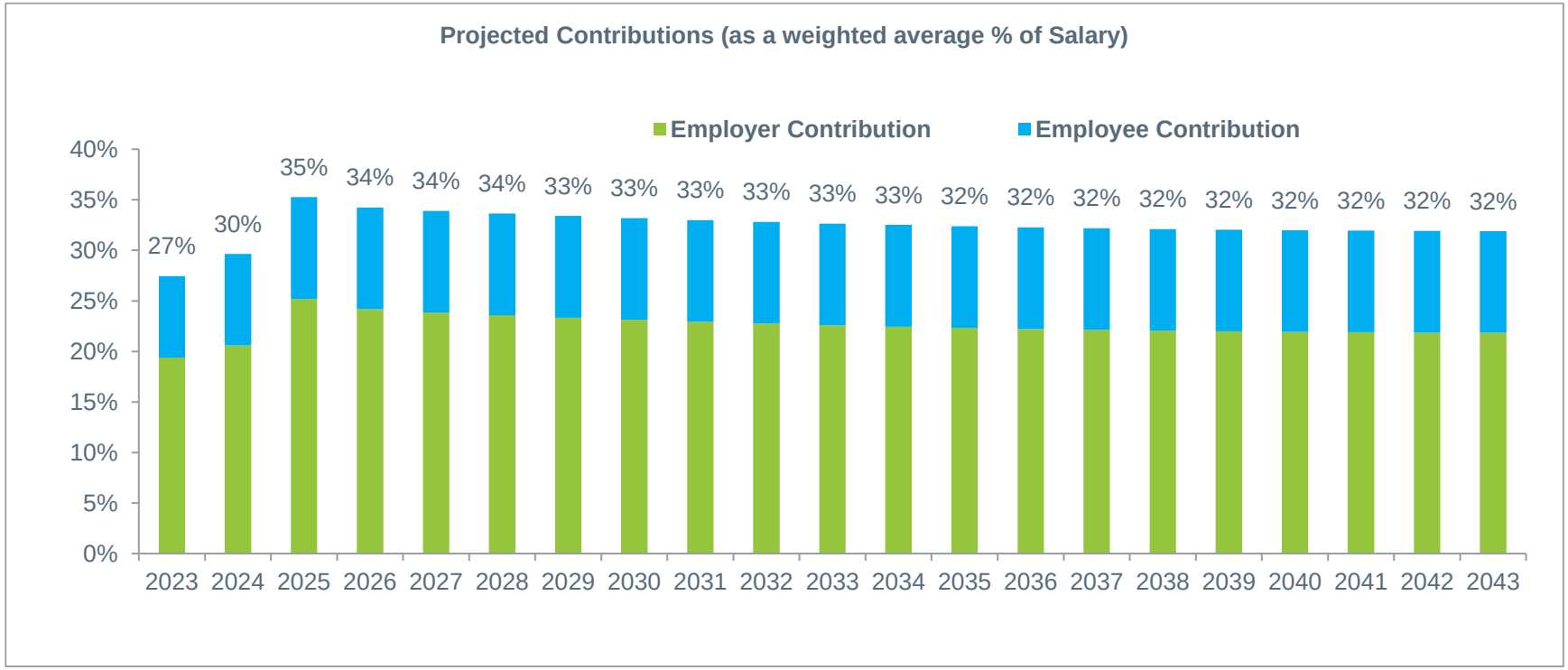
# **Deterministic Analysis** (continued)

## Contributions (weighted average percentage of salary)

The System's projected contributions, expressed as a weighted average percentage of salary, are shown in the chart below. The results assume the contribution policy remains unchanged, and that the System's assets return precisely the actuarially assumed rate each year without exception for all projection years.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Employer** | 19% | 21% | 25% | 24% | 24% | 24% | 23% | 23% | 23% | 23% | 23% | 22% | 22% | 22% | 22% | 22% | 22% | 22% | 22% | 22% | 22% |
| **Employee** | 8% | 9% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% |



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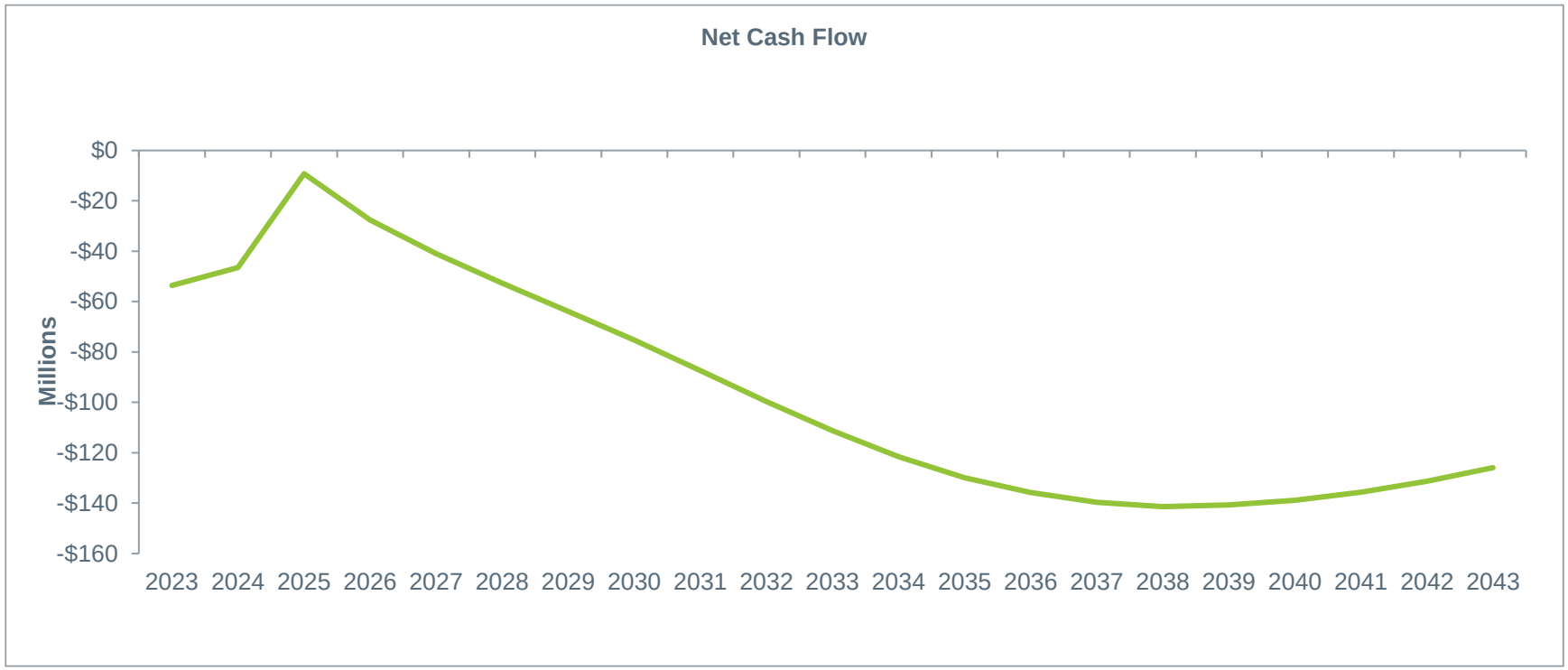
# **Deterministic Analysis** (continued)

### Net Cash Flow (Contributions – Benefit Payments)

The System's projected net cash flow is shown in the chart below. The results assume the contribution policy remains unchanged, and that the System's assets return precisely the actuarially assumed rate each year without exception for all projection years.




### As % of Market Value

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Net Cash Flow** | 1.8% | 0.3% | 0.3% | 0.8% | 1.1% | 1.4% | 1.6% | 1.8% | 2.0% | 2.1% | 2.3% | 2.4% | 2.5% | 2.5% | 2.4% | 2.4% | 2.3% | 2.1% | 2.0% | 1.8% | 1.7% |



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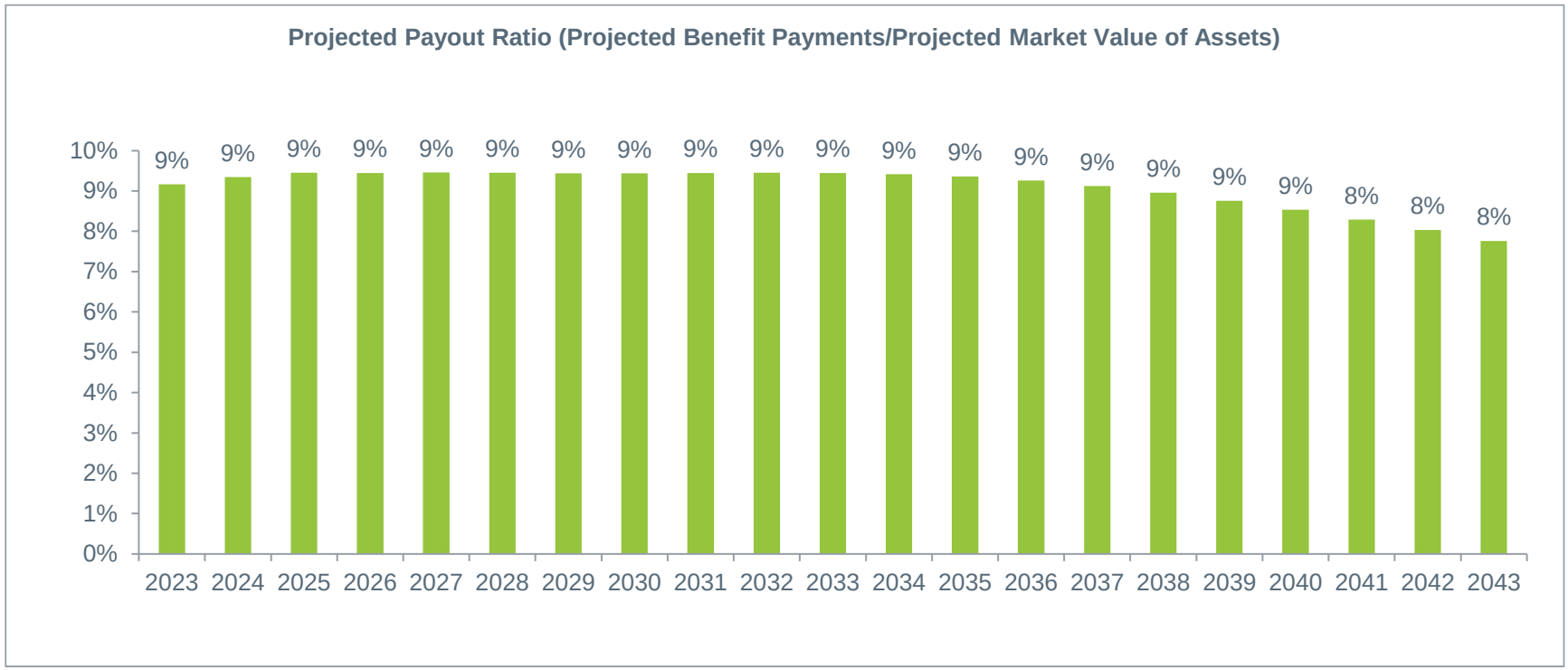
# **Deterministic Analysis** (continued)

### Payout Ratio (benefit payments/market value of assets)

The System's projected payout ratios are shown in the chart below. The payout ratio is expected to remain constant through the end of the projection period. The results assume the contribution policy remains unchanged and that the System's assets return precisely the actuarially assumed rate each year without exception for all projection years.



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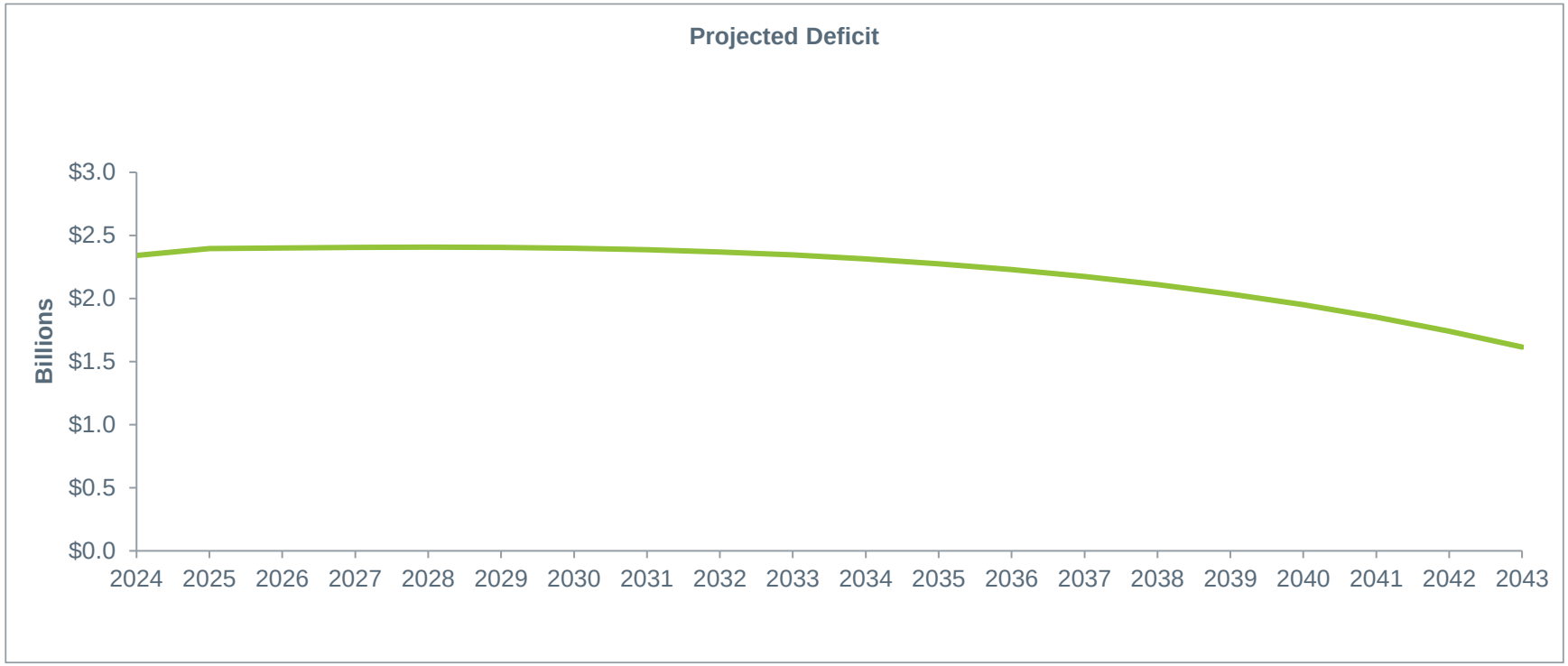
# **Deterministic Analysis** (continued)

### Deficit (market value of assets – actuarial accrued liabilities)

The System's projected deficit of assets is shown in the chart below. The results assume the contribution policy remains unchanged, and that the System's assets return precisely the actuarially assumed rate each year without exception for all projection years. The disparity between the market value of assets and System liabilities is expected to decrease by the end of the projection period by 31%.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Deficit** | $2.3 | $2.3 | $2.4 | $2.4 | $2.4 | $2.4 | $2.4 | $2.4 | $2.4 | $2.4 | $2.3 | $2.3 | $2.3 | $2.2 | $2.2 | $2.1 | $2.0 | $2.0 | $1.9 | $1.7 | $1.6 |



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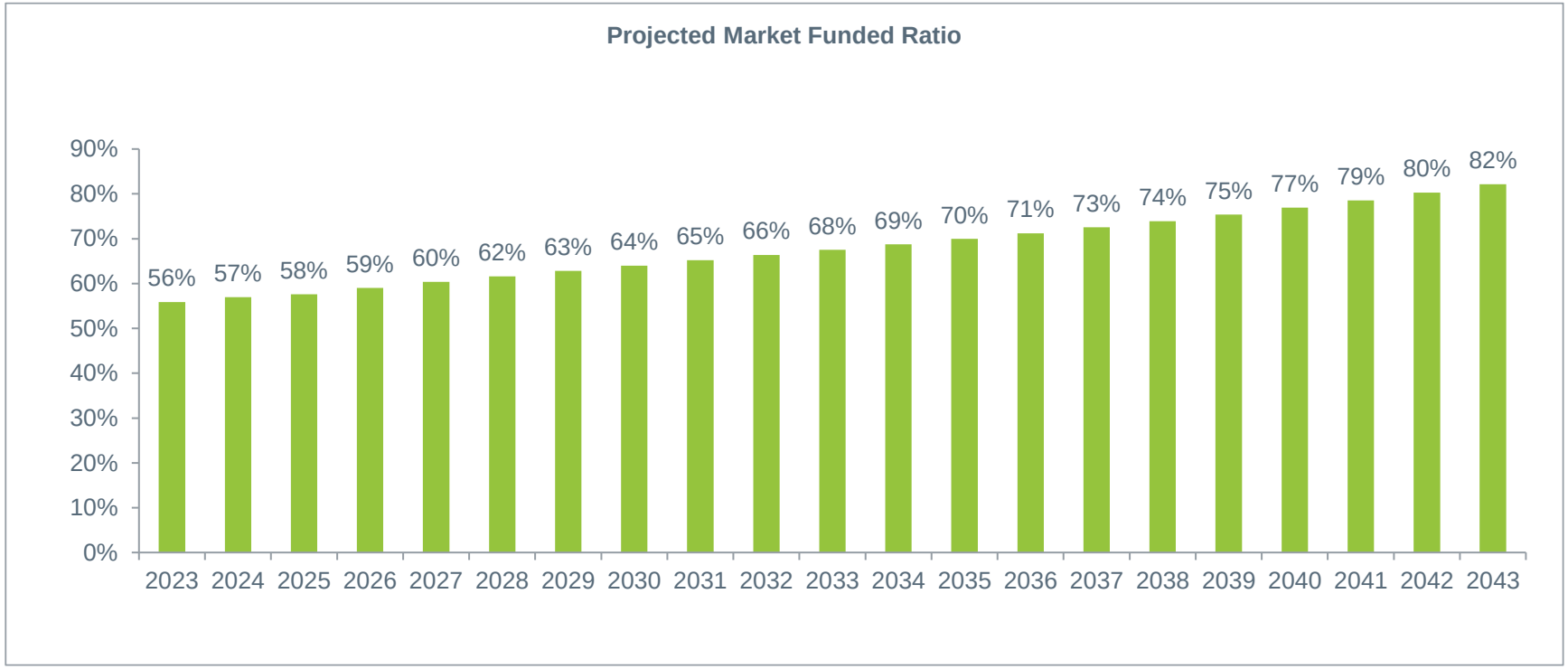
# **Deterministic Analysis** (continued)

### Market Funded Ratio (market value of assets/actuarial accrued liability)

The System's projected market funded ratio is shown in the chart below. The System is expected to end the projection period at approximately 82% funded. The results assume the contribution policy remains unchanged, and that the System's assets return precisely the actuarially assumed rate each year without exception for all projection years.



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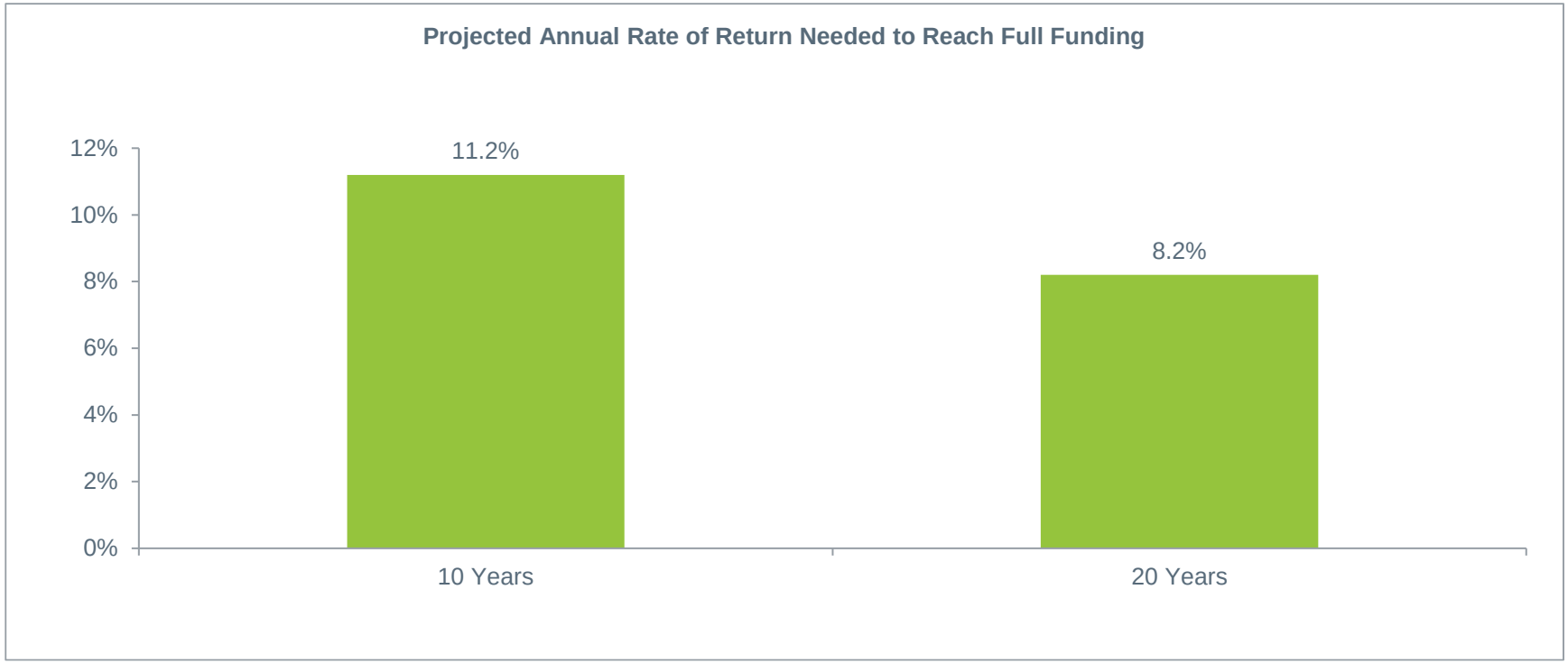
# Deterministic Scenario Analysis

## Full Funding Implied Returns

The figure below shows the projected investment return for the total fund needed to bring the System to 100% funding (on a market value basis) in 10 and 20 years, respectively. The results assume all other actuarial assumptions are precisely met over the time periods shown and that these returns are earned for every year, without variance.

Actuarially assumed rate of return – **6.75%**



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# Deterministic Scenario Analysis (continued)

## Sensitivity Analysis

The figure below summarizes the outcomes of the following deterministic scenarios. The Base Case represents the analysis completed in the Deterministic Analysis section of this report, assuming an asset return of -15.6% in 2022, and assumes the current actuarially assumed rate of return (6.75%). The results assume all other actuarial assumptions are precisely met over the time periods shown and that these returns are earned for every year, without variance.

A. **V Shaped Recovery** – The V scenario assumes a return of +20% in 2023 followed by the assumed rate of return thereafter (6.75%).
B. **W Shaped Market Event** – The W scenario assumes a return of +20% in 2023, -15% in 2024, +15% in 2025 followed by the assumed rate of return thereafter (6.75%).
C. **Future V Shaped Market Event** – This scenario assumes a return of -10% in 2032, +10% in 2033, and the assumed rate of return (6.75%) in all other projection years.
D. **Future W Shaped Market Event** – This scenario assumes a return of -15% in 2032, +15% in 2033, -15% in 2034, +15% in 2035, and the assumed rate of return (6.75%) in all other projection years.
E. **6.00%** – Assets earn 6.00% each and every year after 2022.
F. **Loss then Low** – 10% loss in 2023 followed by a lower return environment (6.00%).
G. **Persistent Inflation** – Assets earn 6.75% each and every year (after 2022) but wage inflation is 5.00% per year during the 20-year projection period.

| | Value in 2043 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Base Case | Scenario A | Scenario B | Scenario C | Scenario D | Scenario E | Scenario F | Scenario G |
| Projected Payout Ratio | 8% | 8% | 8% | 9% | 11% | 9% | 10% | 8% |
| Projected Employer Contributions (millions) | $308.9 | $258.3 | $332.5 | $348.7 | $348.7 | $348.7 | $348.7 | $449.5 |
| Projected Employee Contributions (millions) | $138.3 | $138.3 | $138.3 | $138.3 | $138.3 | $138.3 | $138.3 | $217.4 |
| Projected Actuarial Accrued Liabilities (billions) | $9.1 | $9.1 | $9.1 | $9.1 | $9.1 | $9.1 | $9.1 | $12.2 |
| Projected Market Value of Assets (billions) | $7.4 | $7.6 | $7.3 | $6.6 | $5.4 | $6.7 | $5.7 | $9.1 |
| Projected Surplus/(Deficit) (billions) | ($1.6) | ($1.5) | ($1.8) | ($2.4) | ($3.6) | ($2.4) | ($3.3) | ($3.2) |
| Projected Market Funded Ratio | 82% | 84% | 80% | 73% | 60% | 74% | 63% | 74% |
| | 20 Year Cumulative Total (2023-2042) | | | | | | | |
| Projected Cumulative Employer Contributions (billions) | $4.79 | $4.12 | $4.93 | $5.11 | $5.12 | $5.13 | $5.33 | $5.94 |
| Projected Cumulative Employee Contributions (billions) | $2.12 | $2.12 | $2.12 | $2.12 | $2.12 | $2.12 | $2.12 | $2.75 |
| % Change from Base Case | -- | -14% | 3% | 7% | 7% | 7% | 11% | 24% |



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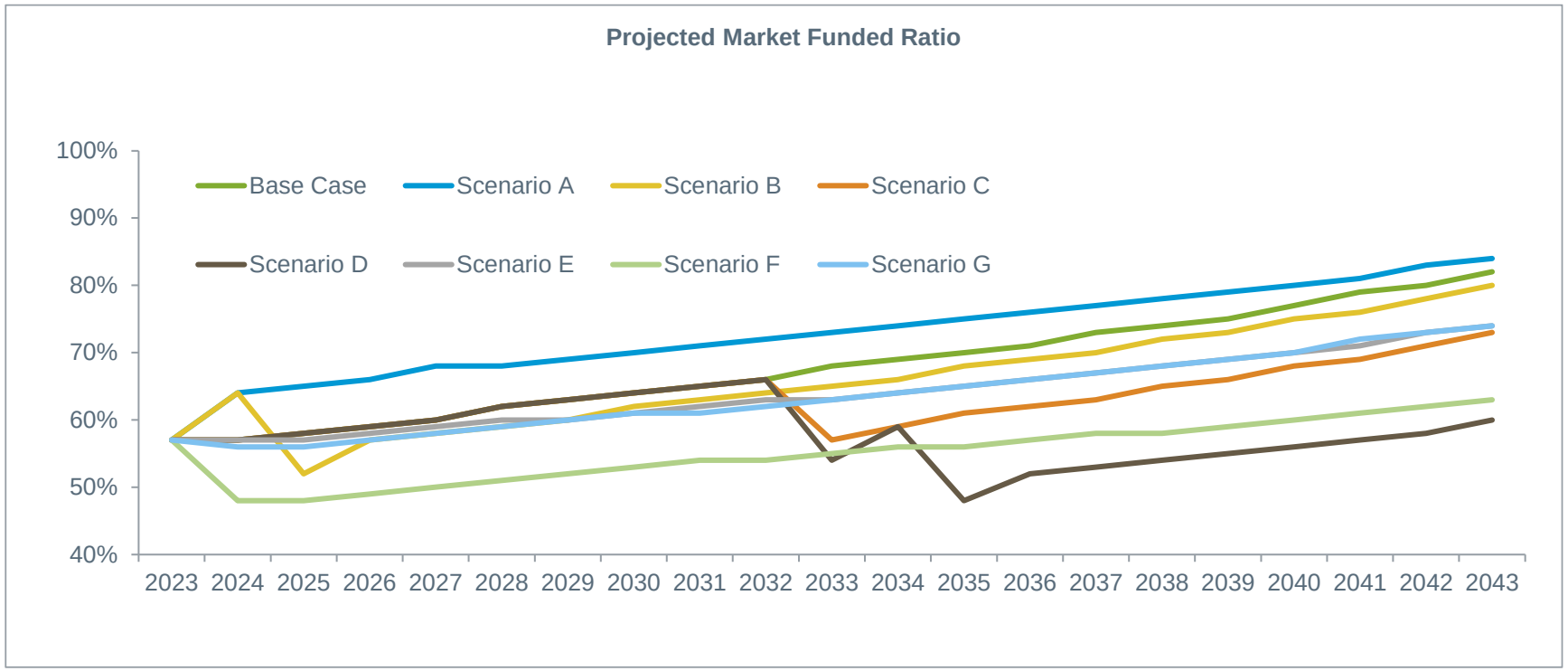
# **Deterministic Scenario Analysis** (continued)

### Sensitivity Analysis

The figure below summarizes the projected funded ratio for the scenarios shown on the previous page. The results assume all other actuarial assumptions are precisely met over the time periods shown and that these returns are earned for every year, without variance.



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## Stochastic Analysis

In the previous section of this report, we assumed the System operated going forward with certain knowledge of the future investment returns earned by the System's assets. This section introduces the element of uncertainty in those future investment returns. This part of the analysis examines System assets and liabilities under many capital market environments based on expected future asset returns and inflation, and their expected volatility. Using a Monte Carlo simulation technique, both assets and liabilities are assumed to vary stochastically, linked together by changes in inflation.

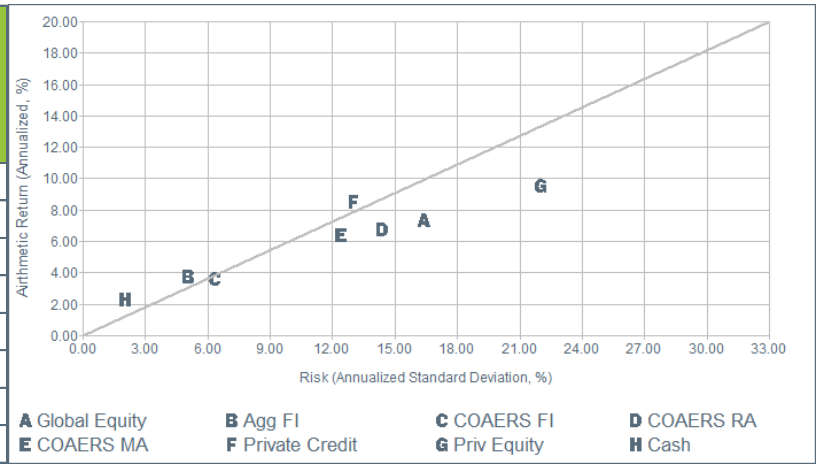
Using the current expected values and variances of the returns and inflation, along with their correlations, 2,000 trials are generated to produce a distribution of results. A stochastic analysis can answer questions about the best/worst case outcomes along with the probability of such outcomes. This is contrasted with the deterministic analysis that provides an expected value if all current System assumptions are exactly met.

# **Stochastic Analysis** (continued)

## Long-Term Return and Risk Assumptions

In order to perform a stochastic analysis and create asset allocation alternatives, it is necessary to estimate, for each asset class, its probable return and risk. The expected returns are our best estimates of the average annual percentage increases in values of each asset class over a prospective long period of time (RVK assumptions are based on a 20 year horizon), and assumed to be normally distributed. The risk of an asset class is measured by its standard deviation, or volatility. If asset returns are normally distributed, two-thirds (67%) of all returns are expected to lie within one standard deviation on either side of the mean. For example, we expect Global Equity to return, annually on average, 7.85% with a standard deviation of 16.40%, meaning that two-thirds of the time we expect its return to lie between -8.55% (= 7.85 – 16.40) and 24.25% (= 7.85 + 16.40). Moreover, we expect 95% of all return outcomes to lie within two standard deviations of the mean return, implying only a one-in-twenty chance that the return on Global Equity will either fall below -24.95% or rise above 40.65%. The risk and return assumptions used in this study are outlined in the below table and chart. RVK's capital markets assumptions reflect passive investments (where possible) and are net of investment management fees.

| Asset Class | Arithmetic Return Assumption | Geometric/ Compound Return Assumption | Standard Deviation Assumption |
|---|---|---|---|
| Global Equity | 7.85 | 6.62 | 16.40 |
| US Agg Fixed Income | 4.00 | 3.88 | 5.00 |
| COAERS Fixed Income | 4.00 | 3.81 | 6.29 |
| COAERS Real Assets | 7.08 | 6.11 | 14.53 |
| COAERS Multi-Asset | 6.87 | 6.17 | 12.32 |
| Private Credit | 8.00 | 7.23 | 13.00 |
| Private Equity | 10.00 | 7.86 | 22.00 |
| Cash Equivalents | 2.50 | 2.48 | 2.00 |




Assumptions noted as COAERS are custom assumptions based on COARERS' implementation of the asset class.
COAERS Fixed Income = 75% US Agg Fixed Income, 25% US Long Duration Government Fixed Income.
COAERS Real Assets = 33% each Core Real Estate, US REITs, and listed Infrastructure.
COAERS Multi-Asset = 56% Global Equity, 21% US Agg Fixed Income, 10% US REITs, 5% Listed Infrastructure, 7% GTAA, and 1% Cash.



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# Stochastic Analysis (continued)

## Correlation Between Asset Classes

Creating a diversified portfolio of asset classes enables the investor to achieve a high rate of return while minimizing volatility of the portfolio. As defined on the previous page, volatility is “risk” or standard deviation. By minimizing the volatility of a portfolio, we produce asset returns that vary less from year to year. Diversification exists because the returns of different asset classes do not always move in the same direction, at the same time, or with the same magnitude. Correlation values are between 1.00 and –1.00. If returns of two asset classes rise or fall at the same time and in the same magnitude, they have a correlation value of 1.00. Conversely, two asset classes that simultaneously move in opposite directions, and in the same magnitude, have a correlation value of –1.00. A correlation of zero indicates no relationship between returns. The assumed correlations are largely based on historical index data, with some qualitative analysis applied. For instance, where appropriate, we weight current history more heavily. The correlation matrix used in this study is shown below:

| | Global Equity | US Agg Fixed Income | COAERS Fixed Income | COAERS Real Assets | COAERS Multi-Asset | Private Credit | Private Equity | Cash Equivalents |
|---|---|---|---|---|---|---|---|---|
| Global Equity | 1.00 | 0.12 | -0.01 | 0.84 | 0.97 | 0.80 | 0.81 | -0.08 |
| US Agg Fixed Income | 0.12 | 1.00 | 0.94 | 0.02 | 0.25 | -0.18 | -0.06 | 0.28 |
| COAERS Fixed Income | -0.01 | 0.94 | 1.00 | -0.15 | 0.11 | -0.30 | -0.18 | 0.21 |
| COAERS Real Assets | 0.84 | 0.02 | -0.15 | 1.00 | 0.89 | 0.82 | 0.73 | -0.08 |
| COAERS Multi-Asset | 0.97 | 0.25 | 0.11 | 0.89 | 1.00 | 0.83 | 0.81 | -0.07 |
| Private Credit | 0.80 | -0.18 | -0.30 | 0.82 | 0.83 | 1.00 | 0.84 | -0.12 |
| Private Equity | 0.81 | -0.06 | -0.18 | 0.73 | 0.81 | 0.84 | 1.00 | -0.21 |
| Cash Equivalents | -0.08 | 0.28 | 0.21 | -0.08 | -0.07 | -0.12 | -0.21 | 1.00 |

The fact that the correlations shown in the table are nearly all positive does not imply that these asset classes do not diversify one another. Their correlations are significantly less than 1.00, meaning we expect a measurable number of instances when the underperformance of one or more of the asset classes will be offset by the outperformance of others. This point is demonstrated on the following pages, which illustrate that diversification into less correlated asset classes can decrease the expected overall volatility of a portfolio.



RVK

# **Stochastic Analysis** (continued)

## Efficient Portfolios

Each frontier portfolio (optimal allocation) is created using target rates of return both above and below the projected rate of return for the current allocation. This range illustrates the trade-off between return and risk; additional return can only be achieved by undertaking additional risk. The table below shows the possible optimal allocations given the selected asset classes and their constraints listed under “Min” and “Max.”

| | Min | Max | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Current Target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Global Equity | **46** | **66** | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 52 | 56 |
| COAERS Fixed Income | **16** | **33** | 32 | 33 | 33 | 33 | 31 | 28 | 26 | 23 | 20 | 16 | 21 |
| COAERS Real Assets | **10** | **20** | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 12 | 10 | 15 |
| COAERS Multi-Asset | **2.5** | **10** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 7 |
| Private Credit | **0** | **10** | 0 | 2 | 5 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 0 |
| Private Equity | **0** | **10** | 0 | 0 | 0 | 0 | 1 | 3 | 6 | 8 | 10 | 10 | 0 |
| Cash Equivalents | **0** | **10** | 10 | 6 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Total | | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | | | | | | | | | | | | | |
| Capital Appreciation | | | 48 | 50 | 53 | 55 | 58 | 61 | 63 | 66 | 68 | 73 | 60 |
| Capital Preservation | | | 42 | 40 | 37 | 34 | 31 | 29 | 26 | 24 | 20 | 17 | 24 |
| Alpha | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Inflation | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 12 | 10 | 16 |
| | | | | | | | | | | | | | |
| **Expected Arithmetic Return** | | | **6.0** | **6.2** | **6.3** | **6.5** | **6.6** | **6.8** | **6.9** | **7.1** | **7.2** | **7.4** | **6.8** |
| **Expected Risk (Standard Deviation)** | | | **9.3** | **9.5** | **9.8** | **10.1** | **10.4** | **10.9** | **11.3** | **11.8** | **12.3** | **13.0** | **12.0** |
| **Expected Compound Return** | | | **5.6** | **5.8** | **5.9** | **6.0** | **6.1** | **6.2** | **6.3** | **6.5** | **6.5** | **6.6** | **6.1** |
| | | | | | | | | | | | | | |
| Expected Sharpe Ratio | | | 0.38 | 0.39 | 0.39 | 0.40 | 0.39 | 0.39 | 0.39 | 0.39 | 0.38 | 0.38 | 0.36 |
| RVK Expected Eq Beta (LCUS Eq = 1) | | | 0.55 | 0.57 | 0.58 | 0.60 | 0.62 | 0.64 | 0.67 | 0.69 | 0.72 | 0.76 | 0.71 |
| RVK Liquidity Metric (T-Bills = 100) | | | 87 | 85 | 82 | 80 | 77 | 75 | 73 | 71 | 69 | 70 | 85 |



RVK

# **Stochastic Analysis** (continued)

### Efficient Portfolios

The table shows the current Target Allocation and highlights five additional portfolios (100% Fixed Income, 60/40 (60% global equity and 40% US aggregate fixed income), a Potential Target, W/PC & PE, and 100% Equity) for consideration throughout this study.

| | 100% FI | 60/40 | Current Target | Potential Target | W/PC & PE | 100% Eq |
|---|---|---|---|---|---|---|
| Global Equity | 0 | 60 | 56 | 53 | 47 | 100 |
| US Agg Fixed Income | 100 | 40 | 0 | 0 | 0 | 0 |
| COAERS Fixed Income | 0 | 0 | 21 | 21 | 19 | 0 |
| COAERS Real Assets | 0 | 0 | 15 | 15 | 15 | 0 |
| COAERS Multi-Asset | 0 | 0 | 7 | 0 | 0 | 0 |
| Private Credit | 0 | 0 | 0 | 10 | 10 | 0 |
| Private Equity | 0 | 0 | 0 | 0 | 8 | 0 |
| Cash Equivalents | 0 | 0 | 1 | 1 | 1 | 0 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| | | | | | | |
| Capital Appreciation | 0 | 60 | 60 | 63 | 65 | 100 |
| Capital Preservation | 100 | 40 | 24 | 22 | 20 | 0 |
| Alpha | 0 | 0 | 0 | 0 | 0 | 0 |
| Inflation | 0 | 0 | 16 | 15 | 15 | 0 |
| | | | | | | |
| **Expected Arithmetic Return** | **4.0** | **6.3** | **6.8** | **6.9** | **7.1** | **7.8** |
| **Expected Risk (Standard Deviation)** | **5.0** | **10.3** | **12.0** | **11.7** | **12.2** | **16.4** |
| **Expected Compound Return** | **3.9** | **5.8** | **6.1** | **6.3** | **6.4** | **6.6** |
| | | | | | | |
| Expected Sharpe Ratio | 0.30 | 0.37 | 0.36 | 0.38 | 0.38 | 0.32 |
| RVK Expected Eq Beta (LCUS Eq = 1) | 0.07 | 0.61 | 0.71 | 0.69 | 0.71 | 0.97 |
| RVK Liquidity Metric (T-Bills = 100) | 85 | 88 | 85 | 77 | 70 | 90 |

# **Stochastic Analysis** (continued)

## Efficient Frontier

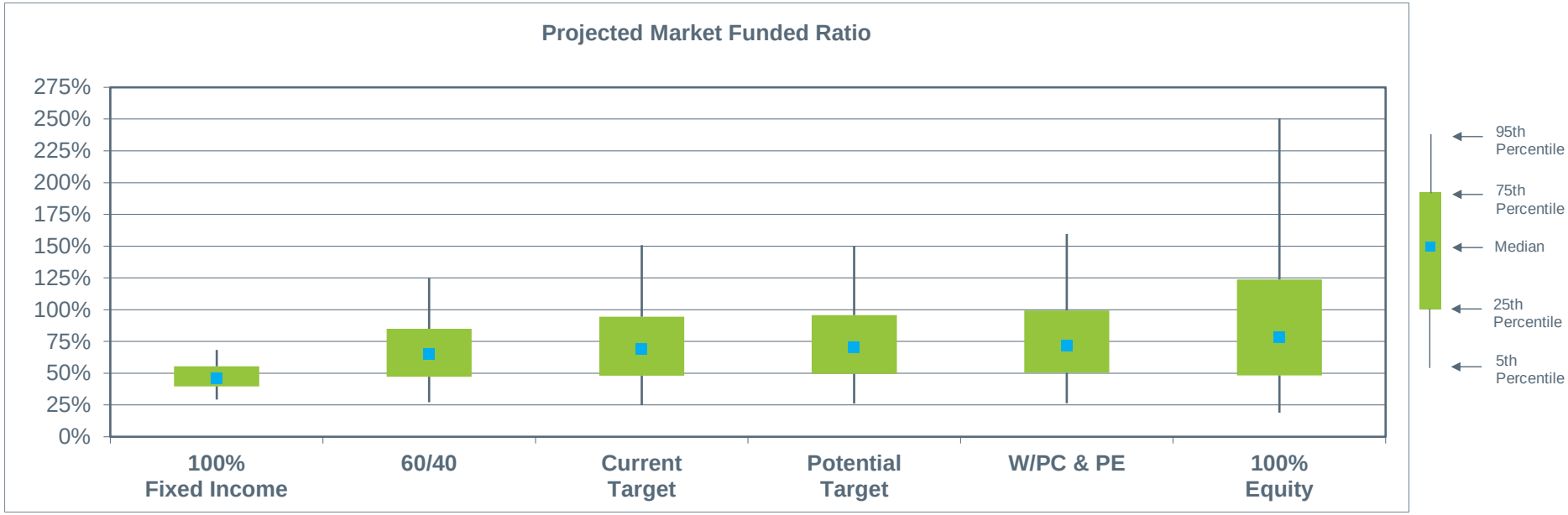
The risk of each alternative allocation is plotted against the horizontal axis, while the return is measured on the vertical axis. Each measure is based on RVK's 20 year capital markets assumptions. The line connecting the points represents all the optimal portfolios subject to the given constraints and is known as the "efficient frontier." The upward slope of the efficient frontier indicates the direct relationship between return and risk.

RVK

# Stochastic Analysis (continued)

**Projected Market Funded Ratio** (market value of assets/actuarial accrued liability); **20 Years**

The graph below shows the distribution of possible market funded ratios twenty years from now, assuming the five different asset mixes highlighted on the prior pages. The results assume the existing contribution policy and assumes investment policies remain unchanged for all projection years. Should assets be depleted in any trial, the model assumes the System becomes pay as you go.




| | 100% Fixed Income | | 60/40 | | Current Target | | Potential Target | | W/PC & PE | | 100% Equity | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unfunded Liability (Bil) | Funded Ratio | Unfunded Liability | Funded Ratio | Unfunded Liability (Bil) | Funded Ratio | Unfunded Liability (Bil) | Funded Ratio | Unfunded Liability (Bil) | Funded Ratio | Unfunded Liability (Bil) | Funded Ratio |
| **5th Percentile** | $6.3 | 29% | $6.6 | 27% | $6.8 | 25% | $6.6 | 26% | $6.6 | 26% | $7.3 | 19% |
| **25th Percentile** | $5.5 | 40% | $4.7 | 47% | $4.7 | 48% | $4.5 | 50% | $4.5 | 50% | $4.7 | 48% |
| **50th Percentile** | $4.8 | 46% | $3.1 | 65% | $2.8 | 69% | $2.7 | 70% | $2.5 | 72% | $1.9 | 79% |
| **75th Percentile** | $4.1 | 55% | $1.4 | 85% | $0.5 | 94% | $0.4 | 96% | $0.1 | 99% | ($2.2) | 124% |
| **95th Percentile** | $2.9 | 68% | ($2.2) | 125% | ($4.6) | 151% | ($4.5) | 150% | ($5.5) | 160% | ($13.8) | 250% |



RVK

## **Stochastic Analysis** (continued)

**Projected Market Funded Ratio and Maximum 1 Year Investment Loss** (market value of assets/actuarial accrued liability)

The tables below show the probability that the System will be at various funding levels for each of the five different asset mixes highlighted on the prior pages. The tables also illustrate the maximum 1 year investment loss each portfolio is expected to experience during the given time period. The results assume the existing contribution policy and assumes investment policies remain unchanged for all projection years. Should assets be depleted in any trial, the model assumes the System becomes pay as you go.

| 5 Years | Probability of Full Funding | Probability of < 56% (Current) Funding | Probability of < 40% Funding | Probability of Asset Depletion | Maximum 1 Year Investment Loss |
|---|---|---|---|---|---|
| 100% Fixed Income | 0% | 64% | 0% | 0% | -13% |
| 60/40 | 0% | 43% | 4% | 0% | -27% |
| Current Target | 2% | 41% | 5% | 0% | -32% |
| Potential Target | 1% | 41% | 5% | 0% | -31% |
| W/PC & PE | 2% | 40% | 5% | 0% | -32% |
| 100% Equity | 8% | 39% | 10% | 0% | -42% |

| 10 Years | Probability of Full Funding | Probability of < 56% (Current) Funding | Probability of < 40% Funding | Probability of Asset Depletion | Maximum 1 Year Investment Loss |
|---|---|---|---|---|---|
| 100% Fixed Income | 0% | 70% | 3% | 0% | -13% |
| 60/40 | 4% | 40% | 8% | 0% | -27% |
| Current Target | 8% | 38% | 10% | 0% | -32% |
| Potential Target | 8% | 37% | 9% | 0% | -31% |
| W/PC & PE | 9% | 37% | 9% | 0% | -32% |
| 100% Equity | 19% | 37% | 15% | 0% | -42% |

| 20 Years | Probability of Full Funding | Probability of < 56% (Current) Funding | Probability of < 40% Funding | Probability of Asset Depletion | Maximum 1 Year Investment Loss |
|---|---|---|---|---|---|
| 100% Fixed Income | 0% | 76% | 26% | 0% | -15% |
| 60/40 | 13% | 37% | 17% | 0% | -30% |
| Current Target | 21% | 34% | 17% | 0% | -32% |
| Potential Target | 22% | 32% | 16% | 0% | -31% |
| W/PC & PE | 24% | 31% | 16% | 0% | -32% |
| 100% Equity | 37% | 31% | 19% | 0% | -42% |

# Stochastic Analysis (continued)

## Drawing Inferences

The tables below compare the projected market funded ratios five, ten, and twenty years from now, under the median (50th percentile), worst-case (5th percentile), and best-case (95th percentile) scenarios, assuming the five different asset mixes highlighted on the prior pages. The table also displays for comparative purposes the median, peak, and trough projected payout ratios and cumulative contributions for the five asset mixes being examined.

| 5 Years | Market Funded Ratio in Year 5 | | | Cumulative Employer Contributions Year 5 (Billions) | | | Payout Ratios | | |
|---|---|---|---|---|---|---|---|---|---|
| | 50th | 5th | 95th | 50th | 5th | 95th | Year 5 Median | Years 1 to 5 Peak | Years 1 to 5 Trough |
| 100% Fixed Income | 54% | 46% | 63% | $1.2 | $1.3 | $1.1 | 11% | 13% | 9% |
| 60/40 | 58% | 42% | 82% | $1.2 | $1.3 | $1.1 | 10% | 14% | 7% |
| Current Target | 59% | 40% | 89% | $1.2 | $1.3 | $1.1 | 10% | 15% | 7% |
| Potential Target | 59% | 40% | 88% | $1.2 | $1.3 | $1.1 | 10% | 15% | 7% |
| W/PC & PE | 60% | 40% | 90% | $1.2 | $1.3 | $1.1 | 10% | 15% | 6% |
| 100% Equity | 61% | 35% | 107% | $1.2 | $1.3 | $1.0 | 10% | 17% | 5% |

| 10 Years | Market Funded Ratio in Year 10 | | | Cumulative Employer Contributions Year 10 (Billions) | | | Payout Ratios | | |
|---|---|---|---|---|---|---|---|---|---|
| | 50th | 5th | 95th | 50th | 5th | 95th | Year 10 Median | Years 1 to 10 Peak | Years 1 to 10 Trough |
| 100% Fixed Income | 52% | 41% | 65% | $2.5 | $2.6 | $2.3 | 12% | 16% | 9% |
| 60/40 | 60% | 37% | 98% | $2.4 | $2.6 | $2.0 | 11% | 17% | 7% |
| Current Target | 62% | 35% | 109% | $2.4 | $2.6 | $1.9 | 10% | 18% | 6% |
| Potential Target | 62% | 36% | 108% | $2.4 | $2.6 | $1.9 | 10% | 18% | 6% |
| W/PC & PE | 63% | 36% | 111% | $2.4 | $2.6 | $1.9 | 10% | 18% | 6% |
| 100% Equity | 66% | 30% | 145% | $2.3 | $2.6 | $1.8 | 10% | 21% | 4% |

| 20 Years | Market Funded Ratio in Year 20 | | | Cumulative Employer Contributions Year 20 (Billions) | | | Payout Ratios | | |
|---|---|---|---|---|---|---|---|---|---|
| | 50th | 5th | 95th | 50th | 5th | 95th | Year 20 Median | Years 1 to 20 Peak | Years 1 to 20 Trough |
| 100% Fixed Income | 46% | 29% | 68% | $5.6 | $6.0 | $5.2 | 14% | 22% | 9% |
| 60/40 | 65% | 27% | 125% | $5.3 | $5.9 | $3.8 | 10% | 24% | 5% |
| Current Target | 69% | 25% | 151% | $5.2 | $5.8 | $3.6 | 9% | 26% | 4% |
| Potential Target | 70% | 26% | 150% | $5.2 | $5.8 | $3.6 | 9% | 25% | 4% |
| W/PC & PE | 72% | 26% | 160% | $5.1 | $5.8 | $3.5 | 9% | 25% | 4% |
| 100% Equity | 79% | 19% | 250% | $4.9 | $5.8 | $3.4 | 8% | 33% | 3% |

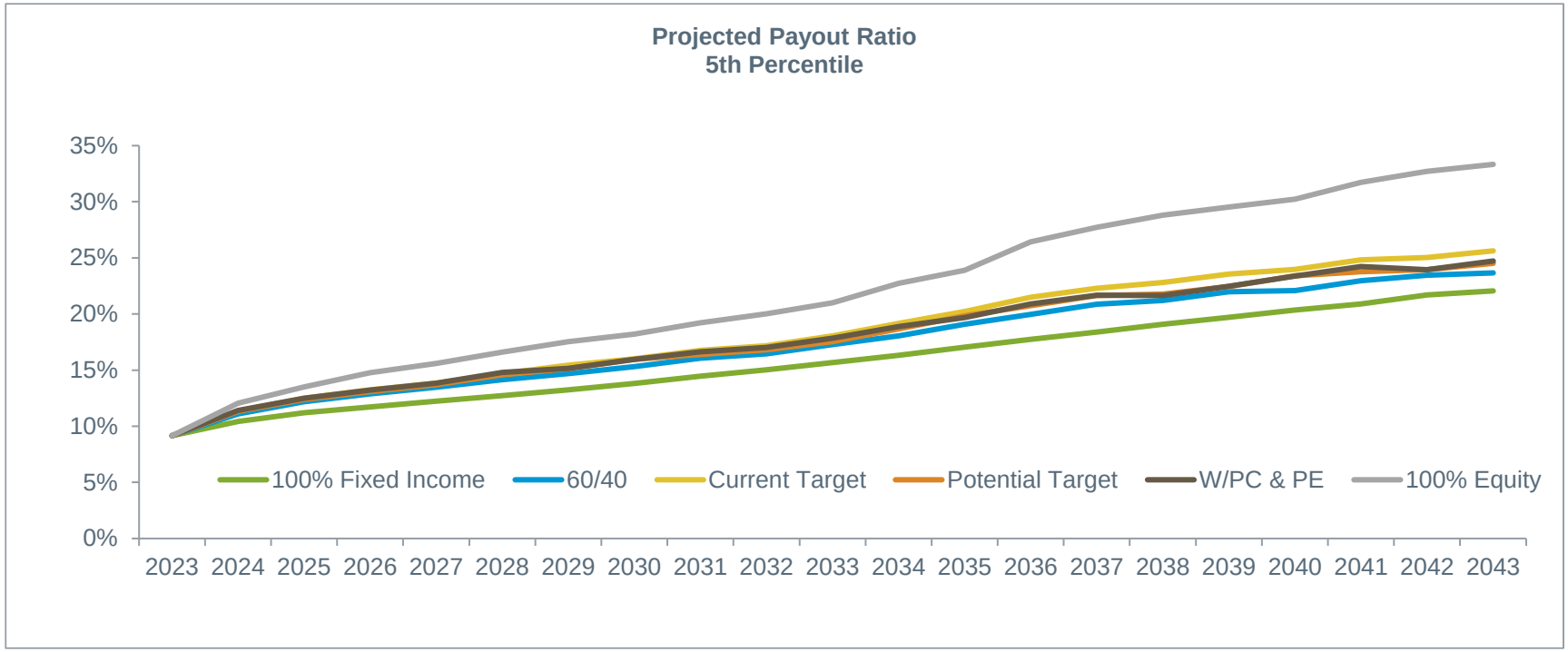


RVK

# **Stochastic Analysis** (continued)

**Projected Payout Ratio** (expected benefit payments/market value of assets) – 5th Percentile

The graph below displays 5th percentile payout ratios over the next twenty years, assuming the five different asset mixes highlighted on the prior pages. The results assume the existing contribution policy and assumes investment policies remain unchanged for all projection years. Should assets be depleted in any trial, the model assumes the System becomes pay as you go, and the payout ratio is 100% thereafter.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **100% Fixed Income** | 9% | 10% | 11% | 12% | 12% | 13% | 13% | 14% | 14% | 15% | 16% | 16% | 17% | 18% | 18% | 19% | 20% | 20% | 21% | 22% | 22% |
| **60/40** | 9% | 11% | 12% | 13% | 13% | 14% | 15% | 15% | 16% | 16% | 17% | 18% | 19% | 20% | 21% | 21% | 22% | 22% | 23% | 23% | 24% |
| **Current Target** | 9% | 11% | 13% | 13% | 14% | 15% | 15% | 16% | 17% | 17% | 18% | 19% | 20% | 21% | 22% | 23% | 24% | 24% | 25% | 25% | 26% |
| **Potential Target** | 9% | 11% | 12% | 13% | 14% | 15% | 15% | 16% | 16% | 17% | 18% | 19% | 20% | 21% | 22% | 22% | 22% | 23% | 24% | 24% | 25% |
| **W/PC & PE** | 9% | 11% | 12% | 13% | 14% | 15% | 15% | 16% | 17% | 17% | 18% | 19% | 20% | 21% | 22% | 22% | 22% | 23% | 24% | 24% | 25% |
| **W/PC & PE** | 9% | 12% | 13% | 15% | 16% | 17% | 18% | 18% | 19% | 20% | 21% | 23% | 24% | 26% | 28% | 29% | 30% | 30% | 32% | 33% | 33% |

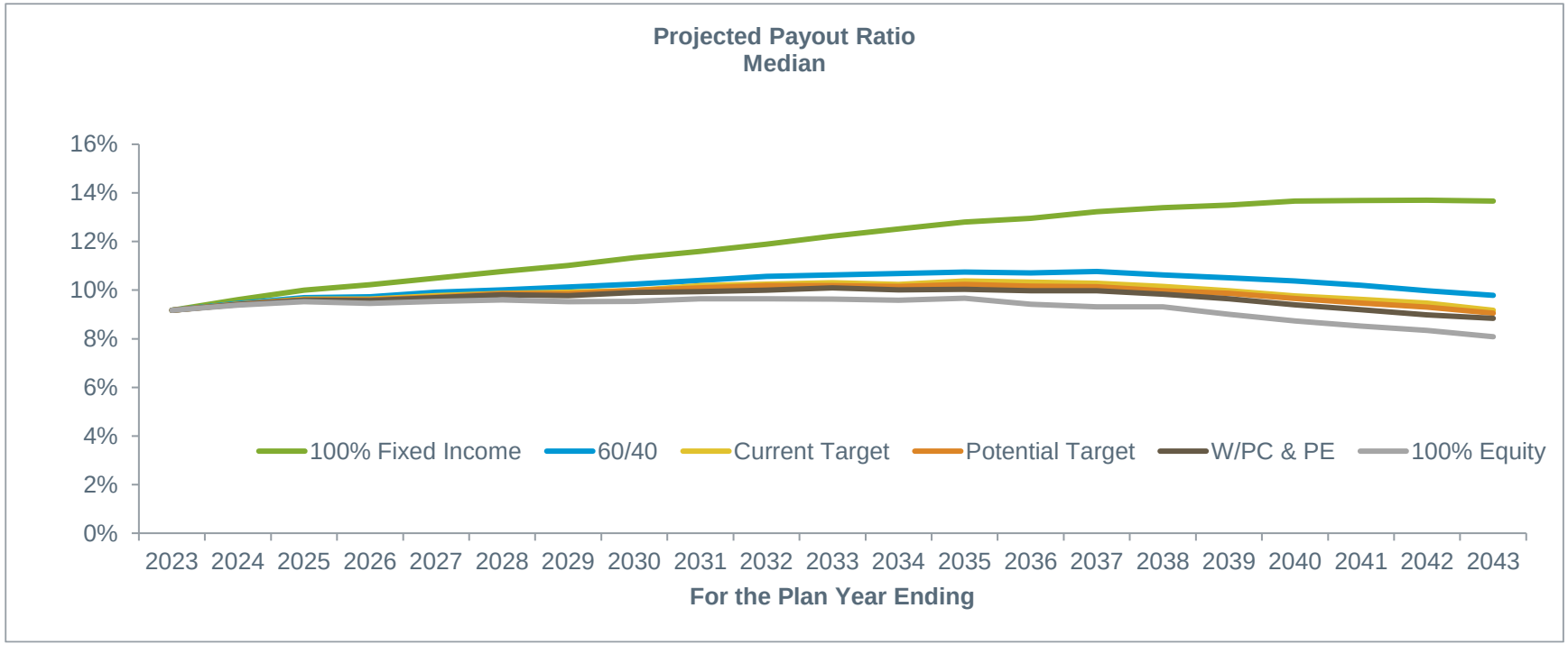


RVK

# **Stochastic Analysis** (continued)

**Projected Payout Ratio** (expected benefit payments/market value of assets) – Median

The graph below displays median payout ratios over the next twenty years, assuming the five different asset mixes highlighted on the prior pages. The results assume the existing contribution policy and assumes investment policies remain unchanged for all projection years. Should assets be depleted in any trial, the model assumes the System becomes pay as you go, and the payout ratio is 100% thereafter.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **100% Fixed Income** | 9% | 10% | 10% | 10% | 11% | 11% | 11% | 11% | 12% | 12% | 12% | 13% | 13% | 13% | 13% | 13% | 13% | 14% | 14% | 14% | 14% |
| **60/40** | 9% | 9% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 11% | 11% | 11% | 11% | 11% | 11% | 11% | 11% | 10% | 10% | 10% | 10% |
| **Current Target** | 9% | 9% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 9% | 9% |
| **Potential Target** | 9% | 9% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 9% | 9% | 9% |
| **W/PC & PE** | 9% | 9% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 9% | 9% | 9% | 9% |
| **100% Equity** | 9% | 9% | 10% | 9% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 9% | 9% | 9% | 9% | 9% | 9% | 8% | 8% |

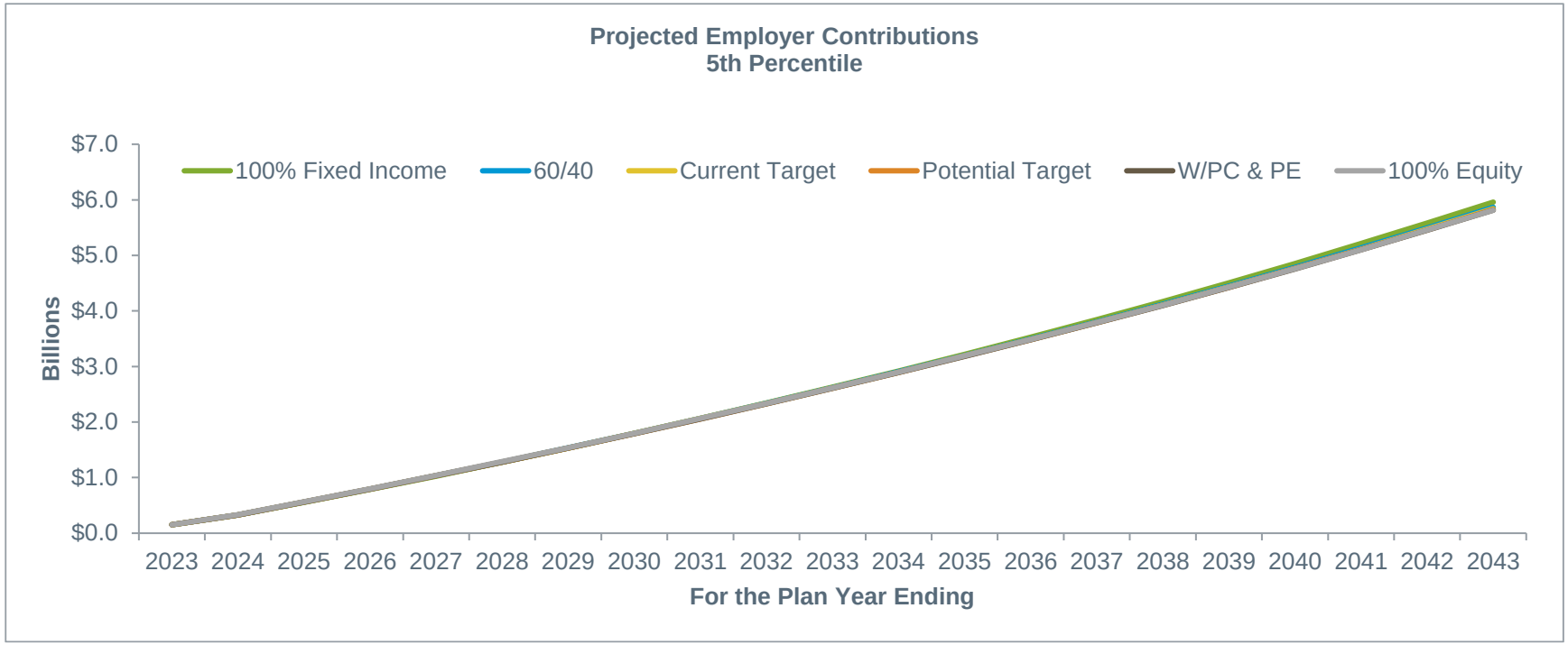


RVK

# Stochastic Analysis (continued)

**Cumulative Employer Contributions to Date** – 5th Percentile

The graph and table below show the 5th percentile projected cumulative employer contributions over the next twenty years assuming the five different asset mixes highlighted on the prior pages. The results assume the existing contribution and investment policies remain unchanged for all projection years. Should assets be depleted in any trial, the model assumes the System becomes pay as you go.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **100% Fixed Income** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.2 | $4.5 | $4.9 | $5.2 | $5.6 | $6.0 |
| **60/40** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.9 |
| **Current Target** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |
| **Potential Target** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |
| **W/PC & PE** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |
| **100% Equity** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |

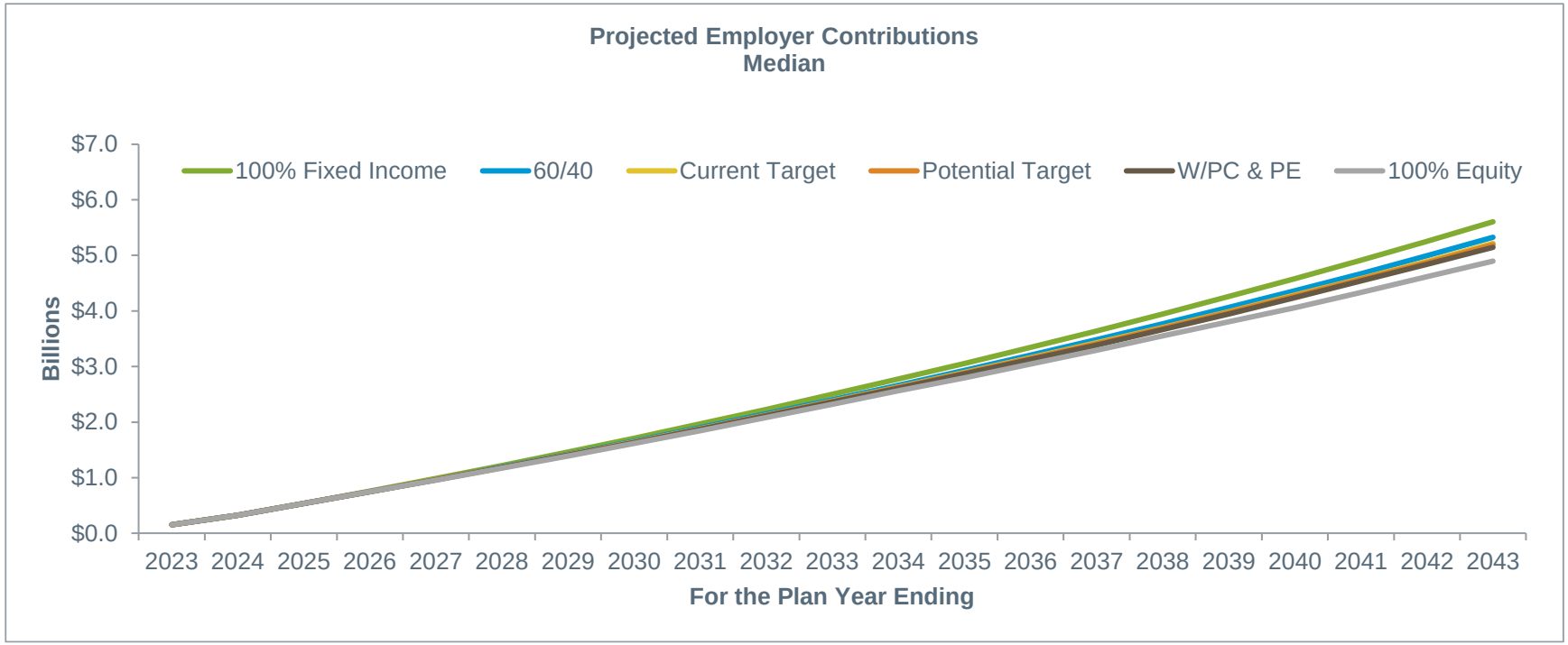


RVK

# **Stochastic Analysis** (continued)

## **Cumulative Employer Contributions to Date** – Median

The graph and table below show the median projected cumulative employer contributions over the next twenty years assuming the five different asset mixes highlighted on the prior pages. The results assume the existing contribution and investment policies remain unchanged for all projection years. Should assets be depleted in any trial, the model assumes the System becomes pay as you go.




| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **100% Fixed Income** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.2 | $4.5 | $4.9 | $5.2 | $5.6 | $6.0 |
| **60/40** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.9 |
| **Current Target** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |
| **Potential Target** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |
| **W/PC & PE** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |
| **100% Equity** | $0.2 | $0.3 | $0.6 | $0.8 | $1.0 | $1.3 | $1.5 | $1.8 | $2.1 | $2.3 | $2.6 | $2.9 | $3.2 | $3.5 | $3.8 | $4.1 | $4.4 | $4.8 | $5.1 | $5.5 | $5.8 |



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## Appendix: Assumptions and Methods

**Actuarial Valuation Assumptions and Methods**: At the beginning of each projection year, an actuarial valuation is performed to determine employer contributions. The assumptions used in the COAERS December 31, 2021 Actuarial Valuation prepared by GRS were utilized in all years. These methods and assumptions are summarized below:

| | |
|---|---|
| **Actuarial Cost Method** | Entry Age Normal Actuarial Cost Method. Funding policies and methods are described in the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |
| **Liability Discount Rate** | 6.75% per year, compounded annually. |
| **Administrative Expenses** | 0.51% of payroll. |
| **Inflation** | General inflation of 2.50% per year, compounded annually. |
| **Future Pay Increases** | Future pay increases as described on page E-4 of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |
| **Retirement** | Rates of retirement as described on page E-2 of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |
| **Mortality** | Rates of mortality as described on page E-1 of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |
| **Disability** | Rates of disablement as described on page E-4 of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |
| **Withdrawal** | Rates of other withdrawal as described on page E-3 of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |
| **DROP Participation** | As described on page E-4 of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |
| **COLA's** | None assumed. |

# Appendix: Assumptions and Methods (continued)

**Actuarial Valuation Assumptions and Methods: (continued)**

| | |
|---|---|
| **Asset Valuation Method** | Five-year smoothing method described on page E-6 of the COAERS December 31, 2021 Actuarial Valuation prepared by GRS. |



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## Appendix: Assumptions and Methods (continued)

**Projection Assumptions (used in the deterministic and stochastic asset/liability projections)**: These projections begin with the System's participant population as of December 31, 2021, as provided by GRS. The System's population is projected forward and assumed to change as a result of employment separation, death, disability, and retirement, as predicted by the assumptions used in the COAERS December 31, 2021 Actuarial Valuation prepared by GRS (and described on the prior pages). New members are assumed to enter the System such that the active population remains level throughout the projection. Employee compensation is projected into the future in accordance with the assumptions described on the prior pages. Investment returns are projected into the future in accordance with the assumptions described below.

| | |
|---|---|
| **Employer Contributions** | Normal cost, plus amortization of unfunded liabilities, subject to corridor restrictions with 2-year phase-in. |
| **Member Contributions** | Current Policy: 8.0% of projected pay.<br>New Policy: For 2022 and 2023: 8.0%,.2024: 9.0%, 2025 and thereafter: 10.0% of projected payroll. Additional employee contributions of up to 2.0% are required beginning in 2024 under certain corridor measurements. |
| **New Entrants** | New employees are assumed to join the System such that the active population remains level throughout the projection. New employees entering the System are assumed to have age, pay, and gender characteristics of recently hired participants. |
| **Rate of Return on Assets** | Deterministic Analysis: For 2022, actual return of -15.6%. Thereafter, 6.75%, compounded annually.<br><br>Stochastic Analysis: For 2022, actual return of -15.6%. Thereafter, returns on the portfolio are based on the expected returns of each asset class and the correlations between each class which are detailed in the Stochastic Analysis section of this report. |
| **Base Wage Component** | Deterministic Analysis: in accordance with actuarial assumptions.<br><br>Stochastic Analysis: Increases that vary with inflation. |

## Appendix: Assumptions and Methods (continued)

| | |
|---|---|
| **Promotion & Productivity Wage Component** | Increases in accordance with actuarial assumptions. |
| **Inflation** | For 2022, 4.5%. Thereafter, 2.50% per year with a standard deviation of 3.00%. |
| **Other** | All other projection assumptions and methods are the same as those used in the COAERS December 31, 2021 Actuarial Valuation prepared by GRS, with minor exceptions.<br><br>Due to system restraints, the following method used by GRS in their actuarial valuation as of December 31, 2021, was approximated:<br><br>1. The Asset Valuation Method was approximated by a 55/45 weighting of the Expected Actuarial Value and Market Value of assets. |



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