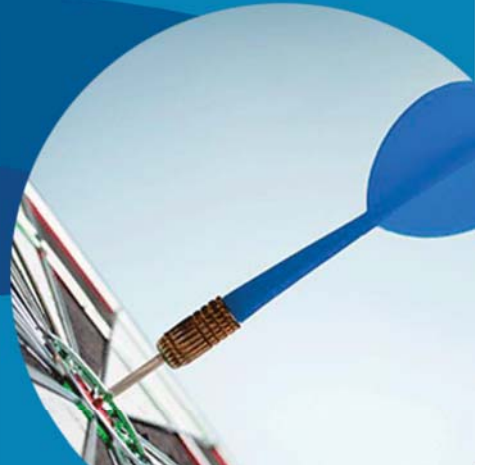




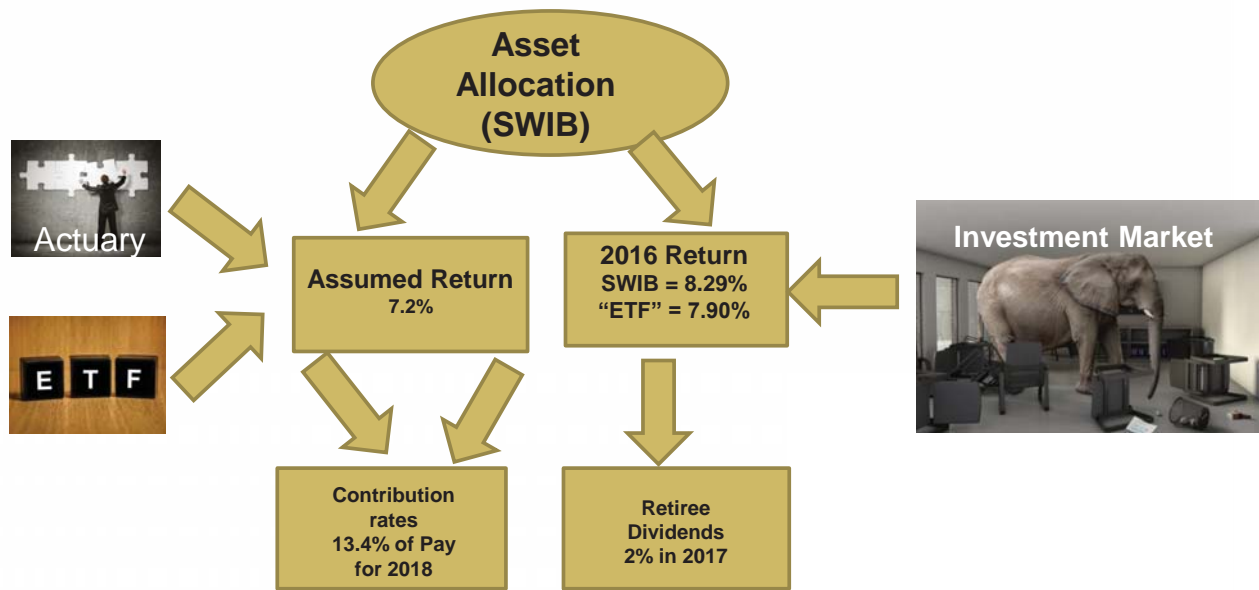
State of Wisconsin Investment Board

Wisconsin Retirement System
Actuarial Overview and Projections

October 2017



Asset Allocation and WRS



Measures of Successful Asset Allocation (WRS Perspective)

- Stable Contribution Rates
- Affordable Contribution Rates
- Generate Dividends (earnings > 5%)
- Avoid Dividend Takebacks
- Maintain fully funded retiree reserve

Asset Allocation Spectrum

Probability of	Asset Allocation Characteristics	
	High Risk	Low Risk
	High Reward	Low Reward
Stable Contribution Rates	Low	High
Affordable Contribution Rates	Medium	Low
Generate Dividends	High	Low
Dividend Takebacks	Medium	Medium
Maintain Fully Funded Retire Reserve	Medium	High *

- An ideal Asset Allocation would provide stable, affordable contribution rates, generate dividends sufficient to offset inflation with no takebacks, and would maintain the retiree reserve in a fully funded position.
- There probably is no such thing, but is there a “Sweet Spot” that provides an optimal combined outcome of all the measures taken together.

* But not in the very long term

Objectives of this Presentation

- Provide an Overview of the WRS
 - Relationship of Investment Return to Success Measures
 - Effects of bad outcomes
- Evaluate several points along the Asset Allocation spectrum against the measures of success.
- Find the “Sweet Spot” if it exists.

WRS Operation

- Benefits
- Plan Governance
 - ETF Board Role
 - SWIB Role
- WRS Accounts and Reserves
- Actuarial Valuation of WRS
 - Sharing Asset Experience
 - Dividend Reserve Depletion

Key Changes from 2015 Study

- Combined SWIB returns for 2015 and 2016 slightly lower than assumed rate of 7.2% (-0.4% return for 2015 and 8.29% return for 2016)
- Mortality table update (slightly longer expected lifetimes)
- Slightly lower Standard Deviation than 2015 Study
- Updated census data as of December 31, 2016

Covered Population at 12/31/2016

	Number	Financial Information		
		Total \$ Millions	Average	Type
Retirees	197,647	\$ 4,887	\$ 24,725	Annual Benefit
Active Members	256,208	13,486	52,637	Annual Pay
Inactive Members	160,897	2,392	14,865	Money Purchase Balance
Total	614,752			



8

WRS Investment Funds

- Core Fund
 - Diversified Portfolio
 - 5 Year Smoothing through Market Recognition Account
- Variable Fund
 - Equity Portfolio
 - Marked to Market each year



9

Market Recognition Account

	For the Year Ended December 31						
	2014	2015	2016	2017	2018	2019	2020
Beginning of year							
a. Funding value	\$81,635,165,224	\$86,109,303,264	\$88,695,483,883	\$92,268,055,484	\$91,754,238,593	\$90,287,000,525	\$89,062,499,057
b. Market value	86,355,982,436	88,649,071,976	85,291,480,633	89,181,973,662	89,181,973,662	89,181,973,662	89,181,973,662
End of year							
c. Market value	88,649,071,976	85,291,480,633	89,181,973,662				
d. Non-investment cash flow (contributions minus benefits)	(2,288,570,809)	(2,738,977,618)	(2,985,477,640)				
e. Investment income							
e1. Total investment income	4,581,660,350	(618,613,725)	6,875,970,669				
e2. Assumed rate	7.2%	7.2%	7.2%				
e3. Amount for immediate recognition	5,795,343,347	6,101,266,641	6,278,597,645	-	-	-	-
e4. Amount for phased-in recognition: e1-e3	(1,213,682,997)	(6,719,880,366)	597,373,024	-	-	-	-
f. Phased-in recognition of investment income							
f1. Current year: 0.2 x e4	(242,736,599)	(1,343,976,073)	119,474,605	-	-	-	-
f2. First prior year	953,421,177	(242,736,599)	(1,343,976,073)	119,474,605	-	-	-
f3. Second prior year	793,268,488	953,421,177	(242,736,599)	(1,343,976,073)	119,474,605	-	-
f4. Third prior year	(936,085,396)	793,268,488	953,421,177	(242,736,599)	(1,343,976,073)	119,474,605	-
f5. Fourth prior year	399,497,833	(936,085,396)	793,268,488	953,421,177	(242,736,599)	(1,343,976,073)	119,474,605
f6. Total MRA recognition	967,365,503	(776,108,404)	279,451,597	(513,816,891)	(1,467,238,068)	(1,224,501,468)	119,474,605
f7. Amount for MRA recognition	-	-	-	-	-	-	-
f8. Total recognized gain (loss)	967,365,503	(776,108,404)	279,451,597	(513,816,891)	(1,467,238,068)	(1,224,501,468)	119,474,605
g. Total recognized investment income: e3 + f8	6,762,708,850	5,325,158,237	6,558,049,241	(513,816,891)	(1,467,238,068)	(1,224,501,468)	119,474,605
h. Funding value end of year: a + d + e3 + f8	86,109,303,264	88,695,483,883	92,268,055,484	91,754,238,593	90,287,000,525	89,062,499,057	89,181,973,661
i. Difference between market and funding values	2,539,768,712	(3,404,003,250)	(3,086,081,822)	(2,572,264,931)	(1,105,026,863)	119,474,605	-
j. Recognized rate of return	8.4%	6.3%	7.5%				
k. Market rate of return (net of fee)	5.4%	(0.7)%	8.2%				



WRS Benefits

- Hybrid Plan
 - Defined Benefit: 1.6% x FAC x Service (Most participants)
 - Not less than twice value of member account (A form of employer match)
- Adjustments are made to the above for members participating in Variable.



WRS Contributions

- Three rate Groups: General/Executive, Protective with and without Social Security.
- Actuarial Valuation determines contributions by rate group.
- General and Executive are now combined - participants split cost equally with employers.
- Protective participants pay the same rate as General participants and employers pay the difference.

WRS Accounts and Reserves

- **Retired Reserve:** Intended to hold exactly the right amount of money so that **IF**
 - each person **lives** exactly the right number of years,
 - **and** gets exactly the same benefit each year
 - **and** the reserve earns exactly 5% each year,
- **Then** the reserve will be exhausted the day the last person dies.

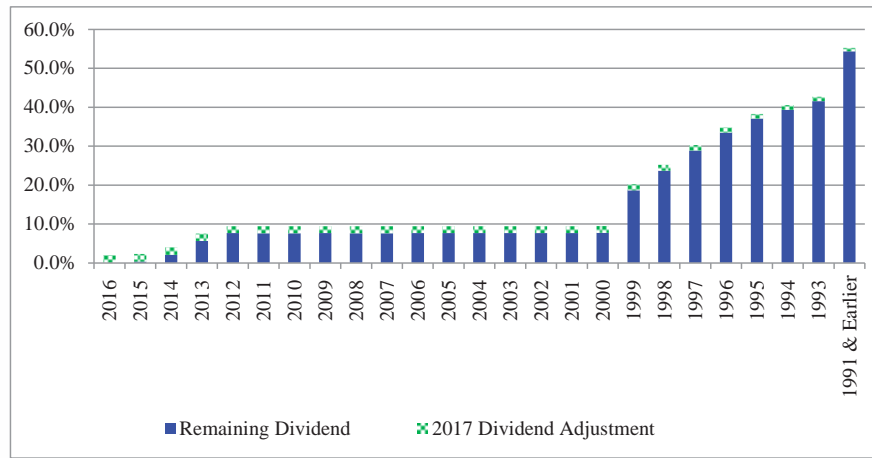
Dividend Reserve

- Retirees share in investment gains, but also share in investment losses. Prior dividends can be reduced if less than 5% is credited to the Core Annuity Division.
- Only dividends can be reduced. The original core benefit is protected.
- The present value of the excess of total core benefits over original benefits is called the “Dividend Reserve”, although there is no formal definition of such a reserve.

Dividend Reserve

- A positive dividend reserve means that retirees are getting some inflation protection, but also provides a means by which the effect of investment losses on employer rates can be dampened.
- A \$0 dividend reserve means that retirees have lost all inflation protection and one of the shock absorbers on employer rates is gone.

Dividend Remaining (as a Percentage of Total Benefit) by Year of Retirement



Dividend Reserve Depletion

- The probability of such an event is low. Even 2008 did not produce depletion.
- In a low and volatile return market environment, realizing a return low enough to deplete the dividend reserve is more likely.
- The following slides explore in general terms what a deficit in the retiree reserve means for the System.

Dividend Reserve Depletion: Liability Attributable to Dividends

<u>Valuation</u>	<u>Liability for Dividend Remaining (billions)</u>	<u>Liability for Dividend Adjustment (billions)</u>
12/31/2010	\$7.2	\$(0.3)
12/31/2011	6.4	(1.7)
12/31/2012	4.5	(1.3)
12/31/2013	3.0	2.0
12/31/2014	4.6	1.3
12/31/2015	5.5	0.2
12/31/2016	5.4	1.0
12/31/2017 (est)	6.0	

- Liability for Dividend Remaining represents the value of all previously granted dividends
- If another market event similar to 2008 were to occur again, the complete depletion of the dividend would become a real possibility



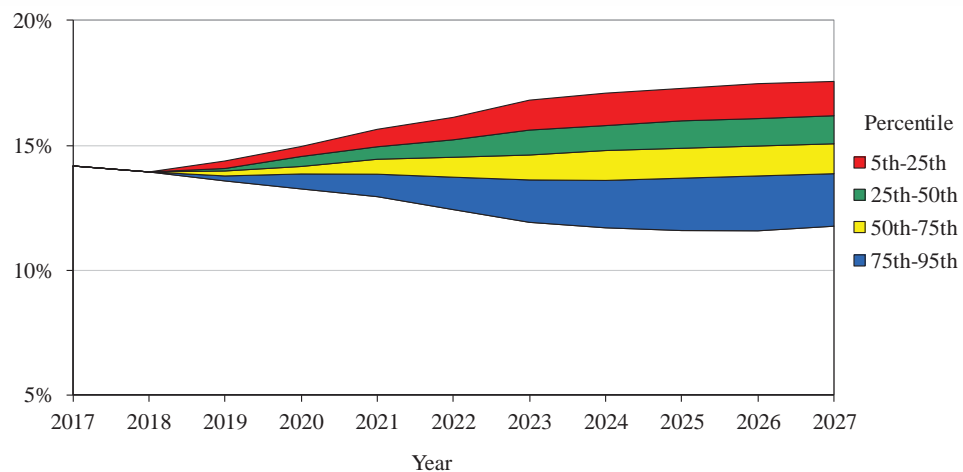
WRS PROJECTIONS

Monte Carlo Simulations

- Based on 10,000 random trials
- Valuation Assumptions held constant
- Assumes seven sets of expected return/standard deviations (provided by NEPC)

	Expected Return		Standard Deviation
	Geometric	Arithmetic	
Current → Scenario 1	5.0%	5.3%	8.2%
Scenario 2	6.0%	6.5%	11.4%
Scenario 3	7.0%	7.9%	15.2%
Scenario 4	7.2%	8.2%	16.0%
Scenario 5	8.0%	9.4%	19.4%
Scenario 6	9.0%	11.1%	24.1%
Scenario 7	10.0%	13.1%	29.5%

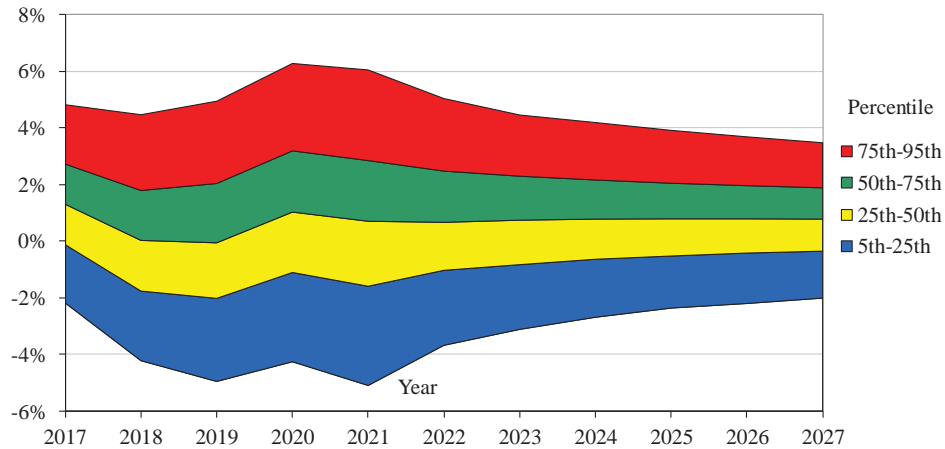
Contribution as a % of Payroll Scenario 2 – 6.0%ER, 11.4%SD



5th Percentile	14.2%	13.9%	14.4%	15.0%	15.6%	16.1%	16.8%	17.1%	17.3%	17.5%	17.6%
25th Percentile	14.2%	13.9%	14.1%	14.6%	14.9%	15.2%	15.6%	15.8%	16.0%	16.1%	16.2%
Median	14.2%	13.9%	14.0%	14.2%	14.4%	14.5%	14.6%	14.8%	14.9%	15.0%	15.1%
75th Percentile	14.2%	13.9%	13.8%	13.9%	13.8%	13.7%	13.6%	13.6%	13.7%	13.8%	13.9%
95th Percentile	14.2%	13.9%	13.6%	13.3%	12.9%	12.4%	11.9%	11.7%	11.6%	11.6%	11.8%

Dividend Rates

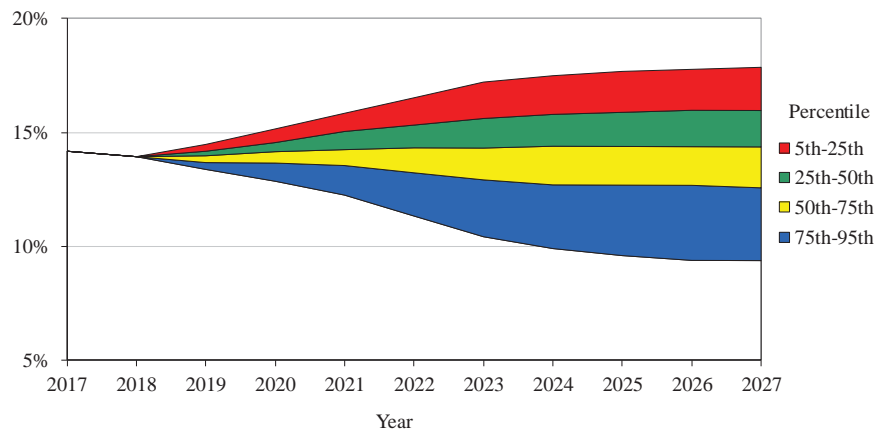
Scenario 2 – 6.0%ER, 11.4%SD



5th Percentile	-2.2%	-4.2%	-5.0%	-4.3%	-5.1%	-3.7%	-3.1%	-2.7%	-2.4%	-2.2%	-2.0%
25th Percentile	-0.1%	-1.8%	-2.0%	-1.1%	-1.6%	-1.0%	-0.8%	-0.6%	-0.5%	-0.4%	-0.4%
Median	1.3%	0.0%	-0.1%	1.0%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%
75th Percentile	2.7%	1.8%	2.0%	3.2%	2.8%	2.5%	2.3%	2.2%	2.0%	2.0%	1.9%
95th Percentile	4.8%	4.5%	4.9%	6.3%	6.0%	5.0%	4.5%	4.2%	3.9%	3.7%	3.5%

Contribution as a % of Payroll

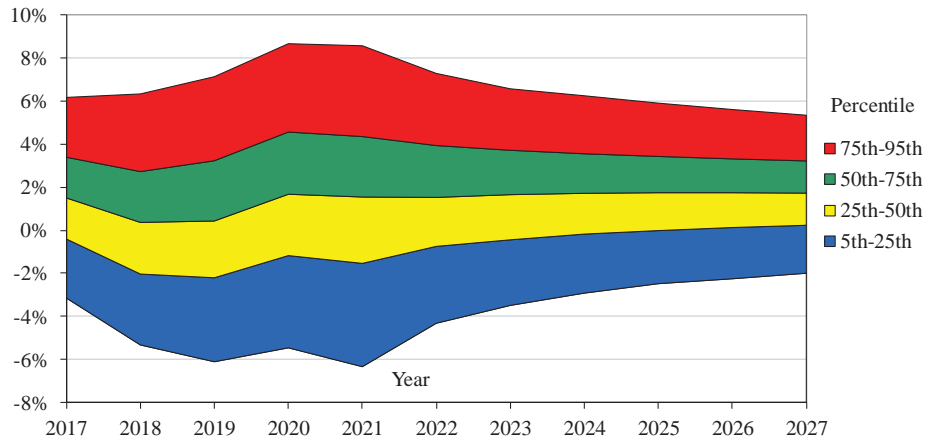
Scenario 3 – 7.0%ER, 15.2%SD



5th Percentile	14.2%	13.9%	14.5%	15.2%	15.8%	16.5%	17.2%	17.5%	17.7%	17.8%	17.9%
25th Percentile	14.2%	13.9%	14.2%	14.6%	15.0%	15.3%	15.6%	15.8%	15.9%	16.0%	16.0%
Median	14.2%	13.9%	14.0%	14.2%	14.2%	14.3%	14.3%	14.4%	14.4%	14.4%	14.4%
75th Percentile	14.2%	13.9%	13.7%	13.7%	13.5%	13.2%	12.9%	12.7%	12.7%	12.7%	12.6%
95th Percentile	14.2%	13.9%	13.4%	12.9%	12.2%	11.3%	10.4%	9.9%	9.6%	9.4%	9.4%

Dividend Rates

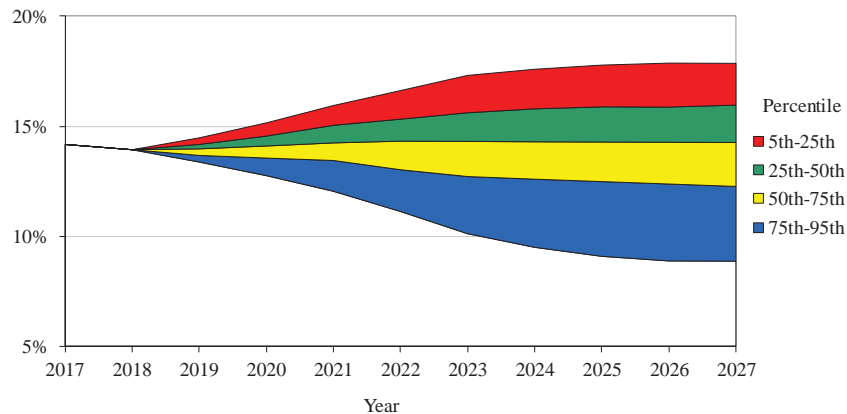
Scenario 3 – 7.0%ER, 15.2%SD



5th Percentile	-3.2%	-5.3%	-6.1%	-5.5%	-6.3%	-4.3%	-3.5%	-2.9%	-2.5%	-2.3%	-2.0%
25th Percentile	-0.4%	-2.0%	-2.2%	-1.2%	-1.5%	-0.8%	-0.4%	-0.2%	0.0%	0.1%	0.2%
Median	1.5%	0.4%	0.4%	1.7%	1.5%	1.5%	1.7%	1.7%	1.7%	1.7%	1.7%
75th Percentile	3.4%	2.7%	3.2%	4.6%	4.4%	3.9%	3.7%	3.6%	3.4%	3.3%	3.2%
95th Percentile	6.2%	6.3%	7.1%	8.7%	8.6%	7.3%	6.6%	6.2%	5.9%	5.6%	5.3%

Contribution as a % of Payroll

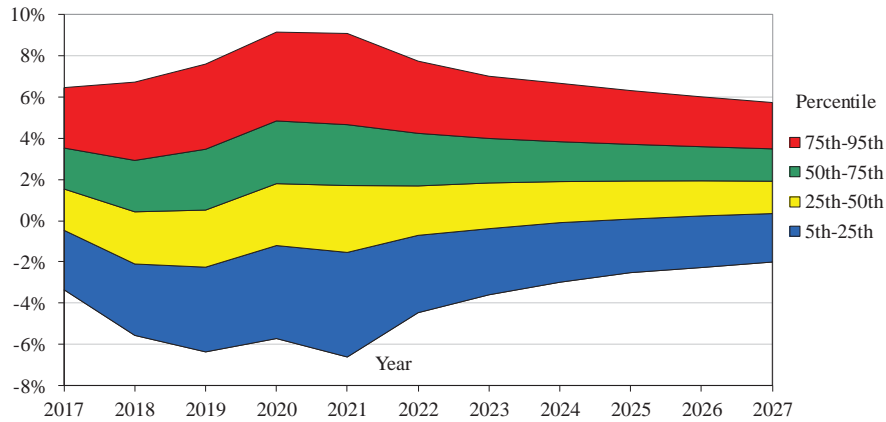
Scenario 4 – 7.2%ER, 16.0%SD



5th Percentile	14.2%	13.9%	14.5%	15.2%	15.9%	16.6%	17.3%	17.6%	17.8%	17.9%	17.9%
25th Percentile	14.2%	13.9%	14.2%	14.6%	15.0%	15.3%	15.6%	15.8%	15.9%	15.9%	16.0%
Median	14.2%	13.9%	14.0%	14.1%	14.2%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
75th Percentile	14.2%	13.9%	13.7%	13.6%	13.4%	13.0%	12.7%	12.6%	12.5%	12.4%	12.3%
95th Percentile	14.2%	13.9%	13.4%	12.8%	12.0%	11.1%	10.1%	9.5%	9.1%	8.9%	8.9%

Dividend Rates

Scenario 4 – 7.2%ER, 16.0%SD



5th Percentile	-3.4%	-5.6%	-6.4%	-5.7%	-6.6%	-4.5%	-3.6%	-3.0%	-2.5%	-2.3%	-2.0%
25th Percentile	-0.5%	-2.1%	-2.3%	-1.2%	-1.5%	-0.7%	-0.4%	-0.1%	0.1%	0.2%	0.3%
Median	1.5%	0.4%	0.5%	1.8%	1.7%	1.7%	1.8%	1.9%	1.9%	1.9%	1.9%
75th Percentile	3.5%	2.9%	3.5%	4.8%	4.7%	4.2%	4.0%	3.8%	3.7%	3.6%	3.5%
95th Percentile	6.5%	6.7%	7.6%	9.2%	9.1%	7.7%	7.0%	6.7%	6.3%	6.0%	5.7%

Discussion of Dividend

Probability That Dividend Reserve Will Be Depleted in Year

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	5.0%	8.2%	0.0%	12.5%	22.7%	30.0%	39.6%
2	6.0%	11.4%	0.0%	15.4%	17.6%	12.4%	3.9%
3	7.0%	15.2%	0.0%	18.2%	16.4%	7.7%	0.9%
4	7.2%	16.0%	0.0%	18.7%	16.4%	7.3%	0.6%
5	8.0%	19.4%	0.0%	20.9%	16.7%	6.5%	0.4%
6	9.0%	24.1%	0.3%	23.2%	18.0%	6.6%	0.3%
7	10.0%	29.5%	0.9%	26.2%	20.0%	7.5%	0.4%

Current →

Discussion of Dividend

Probability of Negative Dividend in Year

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	5.0%	8.2%	23.2%	52.7%	55.8%	54.4%	52.5%
2	6.0%	11.4%	26.6%	42.0%	33.1%	28.8%	28.1%
3	7.0%	15.2%	29.5%	37.1%	23.2%	18.5%	18.8%
4	7.2%	16.0%	29.9%	36.5%	22.0%	17.3%	17.8%
5	8.0%	19.4%	31.7%	34.8%	19.2%	14.5%	14.9%
6	9.0%	24.1%	33.5%	34.3%	17.4%	12.7%	13.3%
7	10.0%	29.5%	34.9%	35.0%	17.2%	12.5%	13.1%

Current →

Discussion of Dividend

Worst Case Scenario of Cumulative Dividend Percent (% of Floor Benefit That Is Funded)

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	5.0%	8.2%	109%	88%	81%	76%	66%
2	6.0%	11.4%	108%	81%	76%	77%	84%
3	7.0%	15.2%	106%	74%	69%	76%	103%
4	7.2%	16.0%	106%	72%	68%	75%	108%
5	8.0%	19.4%	105%	65%	61%	72%	122%
6	9.0%	24.1%	103%	55%	51%	65%	136%
7	10.0%	29.5%	100%	44%	39%	55%	141%

Current →

Worst Case Scenario based on 1st Percentile (i.e., 1% probability)

Dividend Observations

- The low risk scenarios are actually risky in the sense that, for example, 5% expected return has much higher chance of dividend depletion in later years than higher risk scenarios
- Must balance short and long term volatility
- Consider probability of dividend depletion
- Consider level of worst case scenario that is acceptable

Projected Net External Cash Flow* Valuation Assumptions

Year	\$ (Millions)	% of Assets	% of Payroll
2017	\$ (2,853)	(3.2)%	(21.2)%
2027	(4,822)	(4.0)%	(25.5)%
2037	(6,857)	(4.3)%	(26.0)%
2047	(8,034)	(3.8)%	(21.8)%
2057	(10,633)	(3.6)%	(21.1)%
2067	(15,144)	(3.6)%	(21.9)%

*Contribution income minus benefit payout.

Combination of All Scenarios

		2027 Results by %-tile of Investment Return Outcomes								
		Contribution Rates			Dividend Rates			Retiree FS		
		ROR	StdDev	95th	50th	5th	95th	50th	5th	5th Percentile
Current →	1	5.0%	8.2%	13.6%	15.8%	17.5%	1.7%	-0.2%	-2.2%	76% in year 50
	2	6.0%	11.4%	11.8%	15.1%	17.6%	3.5%	0.8%	-2.0%	88% in year 10
	2A	6.15%	12.0%	11.4%	15.0%	17.7%	3.8%	0.9%	-2.0%	87% in year 10
	3	7.0%	15.2%	9.4%	14.4%	17.9%	5.3%	1.7%	-2.0%	85% in year 10
	4	7.2%	16.0%	8.9%	14.3%	17.9%	5.7%	1.9%	-2.0%	84% in year 10
	5	8.0%	19.4%	6.4%	13.7%	18.2%	7.3%	2.7%	-2.1%	80% in year 10
	6	9.0%	24.1%	2.7%	13.0%	18.6%	9.4%	3.6%	-2.4%	74% in year 10
	7	10.0%	29.5%	0.0%	12.3%	19.2%	11.6%	4.4%	-2.9%	65% in year 10

Lower assumed rates of return result in higher expected contributions and lower expected dividends

Higher assumed rates of return are associated higher standard deviation (i.e. risk) and worst case scenario for retiree dividend pool falling below 50%

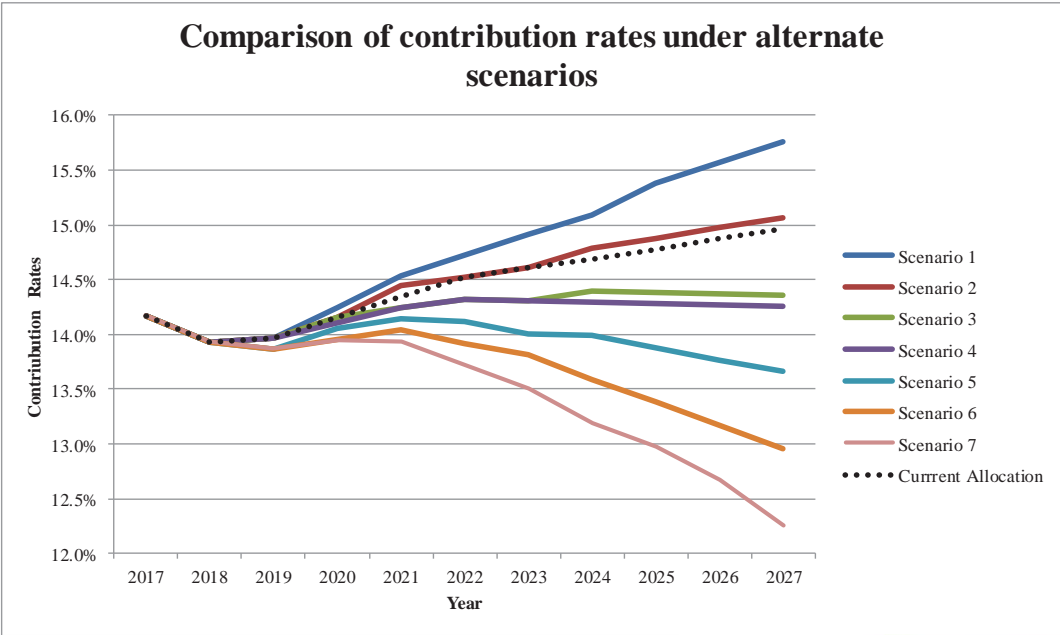
Scenarios 2, 2A, 3 and 4 represent potential 'Goldilocks Zone'

2017 Observations

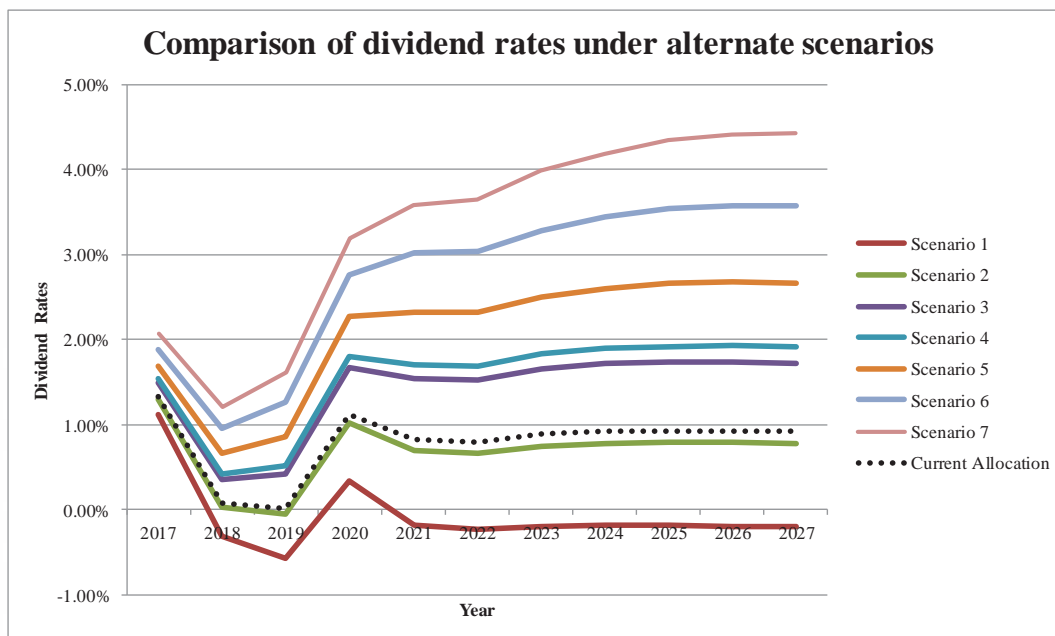
- Changes from 2015 Study
 - Combined returns for 2015 and 2016 slightly lower than assumed rate of 7.2% (-0.4% return for 2015 and 8.29% return for 2016)
 - Mortality table update (slightly longer expected lifetimes)
 - Slightly lower Standard Deviation than 2015 Study
- Overall results are similar to 2015 study
 - Slightly higher probability of depleting dividend reserve due to lower than expected returns
 - This may be offset by asset returns from 1/1/2017 through 12/31/2017
- Continue to target 'Goldilocks zone' that provides for positive return with appropriate downside protection

Appendix

Contribution rate summary under alternate scenarios - median



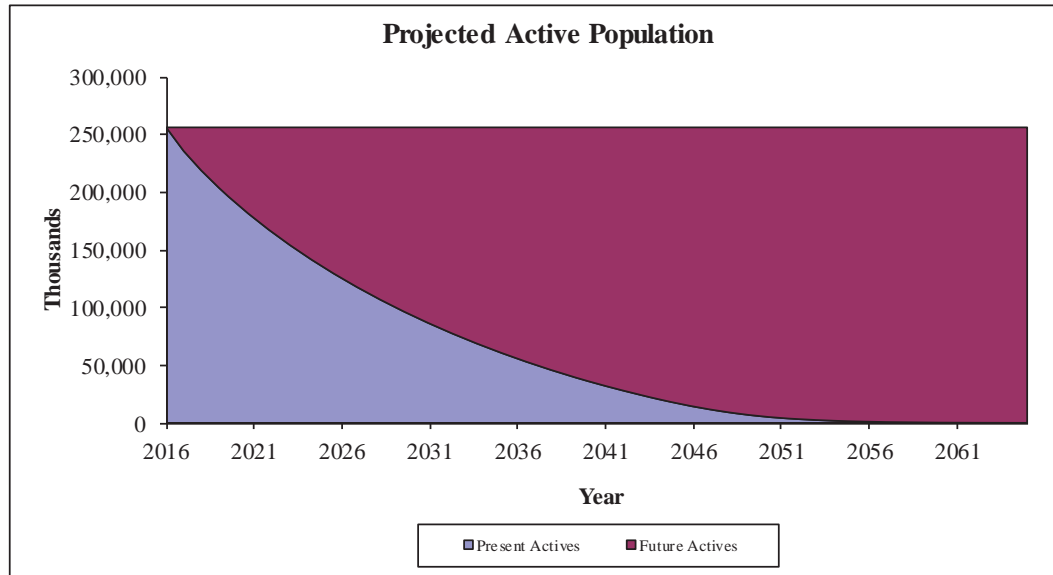
Dividend rate summary under alternate scenarios - median



Present & Future Actives Year by Year results

Year	Present Actives	Future Actives	Year	Present Actives	Future Actives
2014	256,208	-	2039	32,029	224,179
2015	235,652	20,556	2040	28,041	228,167
2016	218,822	37,386	2041	24,254	231,954
2017	203,865	52,343	2042	20,670	235,538
2018	190,155	66,053	2043	17,316	238,892
2019	177,464	78,744	2044	14,212	241,996
2020	165,652	90,556	2045	11,489	244,719
2021	154,619	101,589	2046	9,148	247,060
2022	144,270	111,938	2047	7,183	249,025
2023	134,497	121,711	2048	5,576	250,632
2024	125,312	130,896	2049	4,292	251,916
2025	116,631	139,577	2050	3,277	252,931
2026	108,392	147,816	2051	2,480	253,728
2027	100,568	155,640	2052	1,857	254,351
2028	93,150	163,058	2053	1,378	254,830
2029	86,098	170,110	2054	1,012	255,196
2030	79,371	176,837	2055	738	255,470
2031	72,996	183,212	2056	535	255,673
2032	66,924	189,284	2057	384	255,824
2033	61,122	195,086	2058	273	255,935
2034	55,606	200,602	2059	193	256,015
2035	50,363	205,845	2060	135	256,073
2036	45,391	210,817	2061	92	256,116
2037	40,678	215,530	2062	61	256,147
2038	36,235	219,973	2063	39	256,169

Present & Future Actives



The present population has a “half life” of about 10 years.

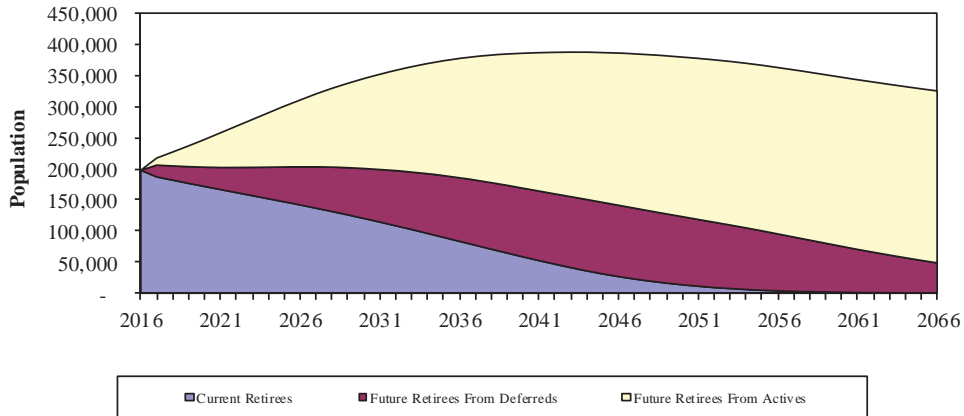
Retiree Population – Present and Future Year by Year Results

Year	Present Retirees	Future from Deferred	Future from Actives	Year	Present Retirees	Future from Deferred	Future from Actives
2016	197,647	-	-	2041	52,470	222,385	111,709
2017	186,931	11,442	18,907	2042	46,730	227,497	112,870
2018	181,738	22,415	22,805	2043	41,261	232,278	113,860
2019	176,555	33,453	26,785	2044	36,110	236,731	114,476
2020	171,553	44,533	30,971	2045	31,317	240,836	114,707
2021	166,623	55,563	35,681	2046	26,912	244,586	114,524
2022	161,681	66,435	40,367	2047	22,919	248,015	113,695
2023	156,818	77,068	45,362	2048	19,345	251,129	112,599
2024	151,978	87,459	50,478	2049	16,189	253,960	111,309
2025	147,006	97,646	55,703	2050	13,437	256,528	109,617
2026	141,921	107,559	61,153	2051	11,063	258,859	107,542
2027	136,717	117,197	66,472	2052	9,038	260,959	105,043
2028	131,360	126,552	71,356	2053	7,328	262,844	102,299
2029	125,873	135,634	75,845	2054	5,900	264,537	99,108
2030	120,224	144,433	80,232	2055	4,720	266,058	95,549
2031	114,420	152,967	84,359	2056	3,755	267,429	91,561
2032	108,468	161,255	88,342	2057	2,974	268,666	87,304
2033	102,378	169,246	92,156	2058	2,348	269,791	82,850
2034	96,173	176,967	96,111	2059	1,851	270,824	78,346
2035	89,880	184,425	99,478	2060	1,457	271,778	73,837
2036	83,532	191,578	102,180	2061	1,148	272,664	69,364
2037	77,167	198,426	104,525	2062	907	273,493	64,946
2038	70,830	204,945	106,792	2063	718	274,272	60,626
2039	64,569	211,123	108,752	2064	572	275,006	56,417
2040	58,432	216,930	110,286	2065	458	275,699	52,327

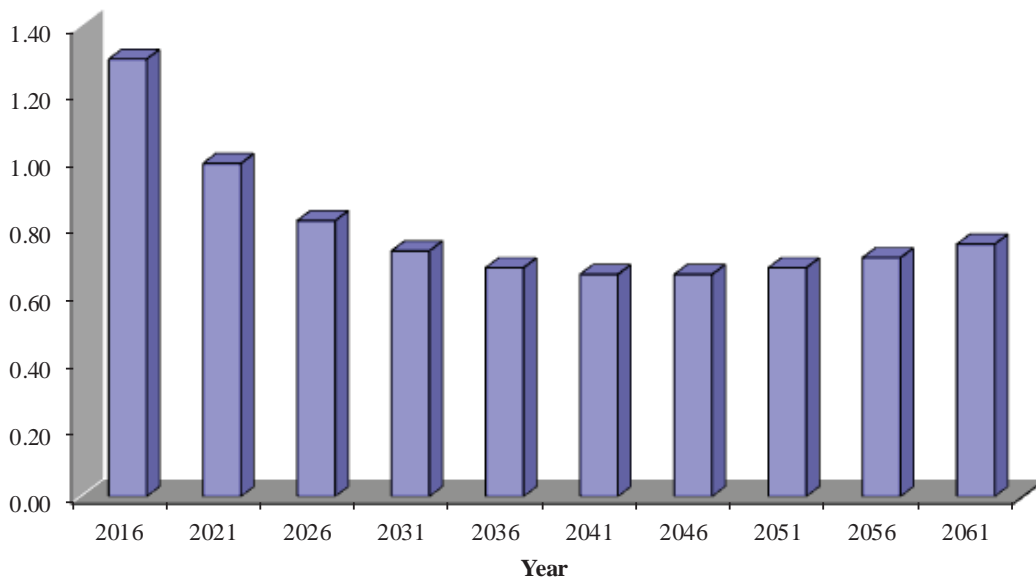


Retiree Population Present and Future

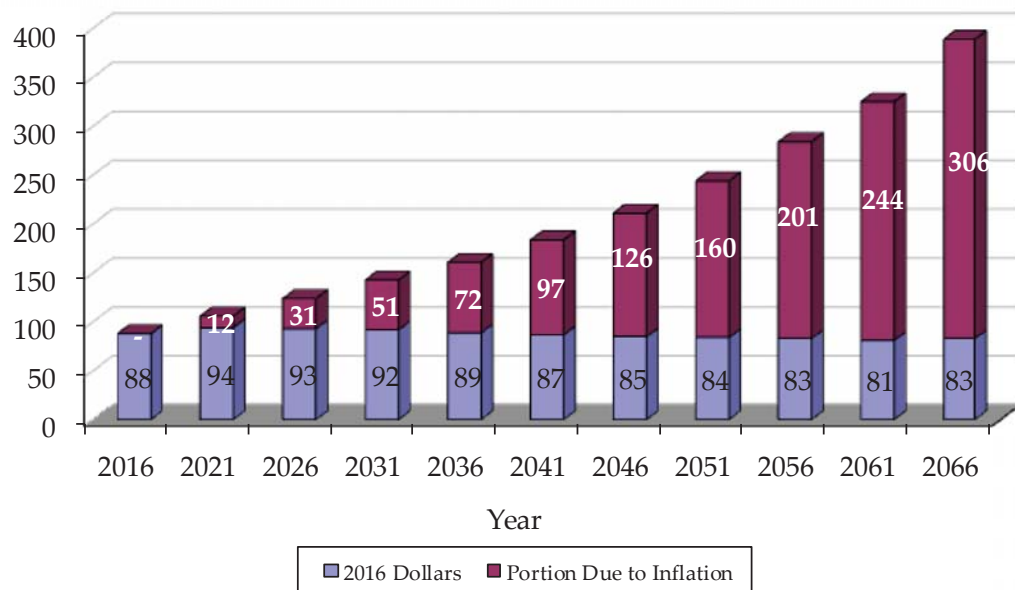
Projected Retiree Population



Ratio of Active Members to Retirees



Projected Core Trust Fund Assets (\$Billions)



Disclaimers

- This presentation shall not be construed to provide tax advice, legal advice or investment advice.
- Readers are cautioned to examine original source materials and to consult with subject matter experts before making decisions related to the subject matter of this presentation.
- This presentation expresses the views of the authors and does not necessarily express the views of Gabriel, Roeder, Smith & Company.