PUB (MPI) 1-124

Part and Chapter:	**Part VII Investments Inv Attachment B Inv Attachment G**	**Page No.:**	**13**
PUB Approved Issue No:	**20. Asset Liability Management Study (in accordance with Directives 11.19 and 11.20 of Order 134/21)**		
Topic:	**ALM Study**		
Sub Topic:	**Basic Claims Portfolio Asset Mix Optimization**		

Preamble to IR:

Question:

a) Please provide a 10-year and 20-year surplus analysis based on the Basic portfolio alternative mixes evaluated in Attachment G.

b) Please comment on how the results of the surplus analysis in (a) supports Mercer's recommended portfolio asset class additions set out in Attachment F p. 3.

Rationale for Question:

To understand potential changes to investment portfolio asset mix.

RESPONSE:

a) Analysing 10-year and 20-year surplus entails a significant amount of work. In *INV Attachment G Mercer Report Asset Mix Optimization Basic Insurance Component Jun 2 22* the probability of deficit was provided only for the final efficient frontier (the one with leverage). ~~MPI has asked~~ Mercer ~~to~~has provided the probability of deficit for all of the efficient frontiers developed for the Basic Claims portfolio. This work ~~will~~ cost an additional $32,000~~ and will not be ready in time to file on August 30. Mercer expects that the analysis will be ready in the first week of September~~. See Attachment A for a revised version of

Mercer Report Asset Mix Optimization Basic Insurance Component, where Mercer has added the probability of deficit metric to the tables on slides 11-14.

We can confirm that the surplus analysis on various generic asset mixes in Phase 1 of the project was done as an initial screen to support whether additional efficient frontier analysis would be done on alternative portfolio mixes. No further surplus analysis was undertaken to support the portfolio selection.

b) Asset class addition is supported or not supported based on the efficient frontier analysis already completed and submitted. The ability to materially increase the risk or reduce the return of the portfolio (i.e., move the efficient frontier up and to the left) is the deciding factor when considering adding new asset classes. Surplus analysis adds no value when considering adding new asset classes.

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Mercer

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Asset Mix Optimization

Preliminary Efficient Frontier Analysis for Basic Insurance Component

MPI Asset Liability Study

2 June 2022 (Updated 5 August 2022 and 6 September 2022 and 9 September 2022)

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Principal

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Principal

A business of Marsh McLennan

Introduction

- Summary of discussions to date:
  - Proposed asset classes
  - Proposed constraints
- Review results of the efficient frontier analysis
- Key goals:
  - Generate discussion on the direction of potential asset mix changes
  - Confirm range of asset mixes to include in the analysis
  - Possibly identify 4 to 5 strategic target asset mixes for further analysis
- Discussion and next steps
- Appendices
  - Capital Market Assumptions

Summary of discussions to date

Asset Classes to be Considered

	Return Seeking	Inflation Sensitive	Interest Rate Sensitive
Broad Markets	Canadian Equity	Real Return Bonds	Canadian T-Bills / Cash
	Global Equity	3x Real Return Bonds	MUSH Bonds
	Global Small Cap		Provincial Bonds
	All Country World Equity		Canadian Corporate Bonds
			3x Long Provincial Bonds
Alternative Investments	Multi-Asset Credit	Infrastructure	Private Debt IG - Universe
		Real Estate	Private Debt IG - Long
			Commercial Mortgages
			Direct Lending (Sub-IG)

Asset classes already included in the target asset mix

Additional asset classes suggested to be included in the analysis

Constraints

Minimally Constrained Approach

Proposed by Mercer

Asset Class	Single	Group
MUSH Private Debt Real Estate Commercial Mortgages	MUSH equal to 20% of total portfolio	Max.[1] 35% of total portfolio

In addition, constraint of 100% interest rate hedge ratio to be applied for Basic.

1. Current max. in IPS is 25%. It was determined that 35% max. on **illiquid asset classes** would be reasonable, given that 28% **liquidity** would be required in a **stressed** scenario:
   a) Projected Basic Claims in Year 1 and Year 2, $323M and $158M respectively or **25%** of Feb 2022 assets
   b) Worst Case Hail Scenario would require an additional $59M (net of reinsurance) or **3%** of Feb 2022 assets

Cost of Constraint Analysis:
For the Basic Long portfolio, the cost of removing the 35% illiquid assets constraint was analyzed. It was determined that removing the 100% interest rate hedge ratio and the 20% allocation to MUSH bonds constraints is not feasible. However, we have also tested the impact of removing the 100% interest rate hedge ratio.

Efficient Frontiers

Overview

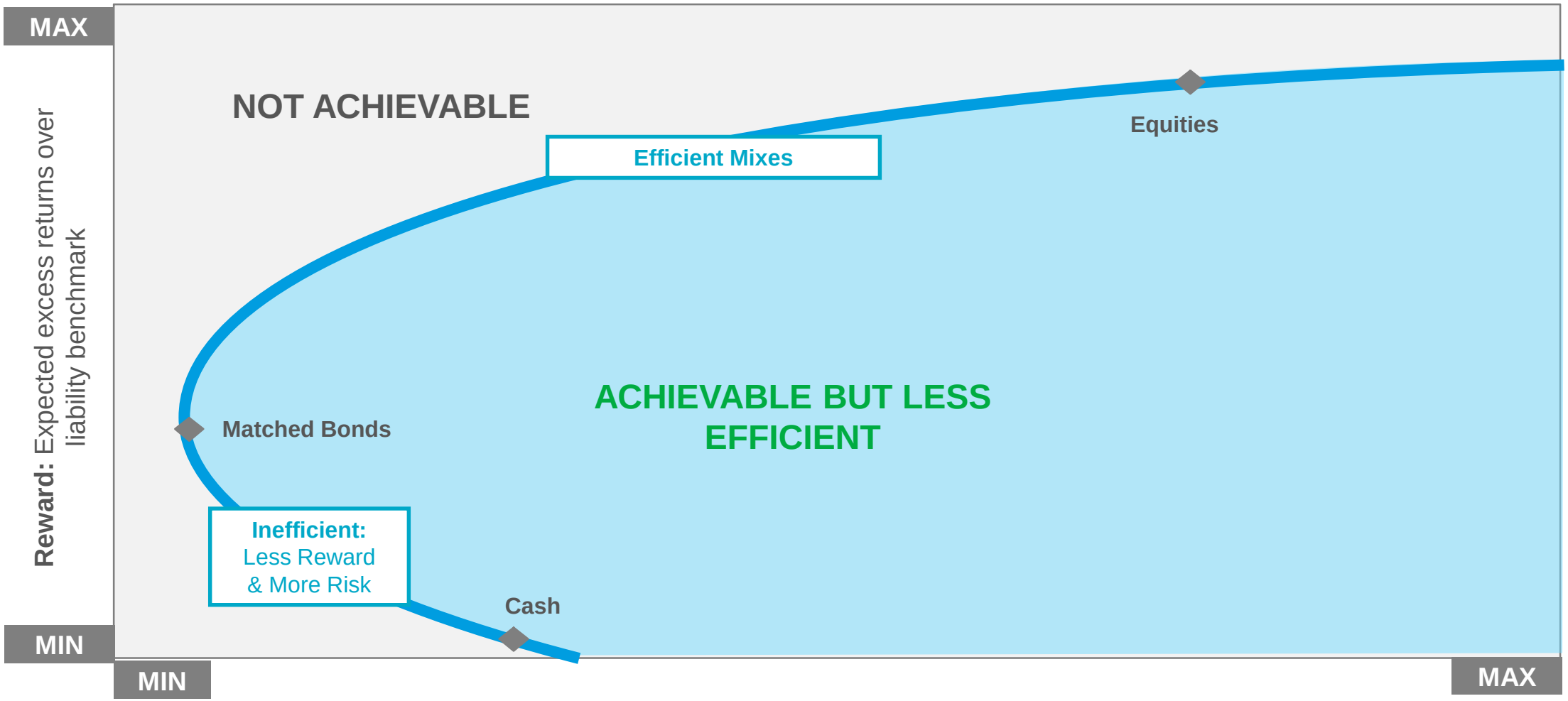
- Characteristics of the efficient frontier tool:
  - One year time horizon
  - Incorporates liabilities through use of a “liability benchmark”
  - Uses optimization techniques to determine asset mixes with optimal risk/return characteristics
  - Flexible tool that can be used to quickly consider many asset mixes
  - Outputs include expected returns and surplus volatility
- Useful for identifying portfolios that:
  - Minimize surplus volatility for a specified level of expected growth; or
  - Maximize expected growth for a specified level of surplus volatility

Note:

- Surplus volatility (i.e., standard deviation) is a measure of the expected volatility of financial position and is expressed on an annualized basis as a percentage of assets
- Surplus volatility of 10% means that there is, roughly, a 1 in 6 chance that the financial position will be:
  - Worse than expected by more than 10% of the starting asset value
  - Better than expected by more than 10% of the starting asset value

Efficient Frontiers

Overview



Interest Rate Risk

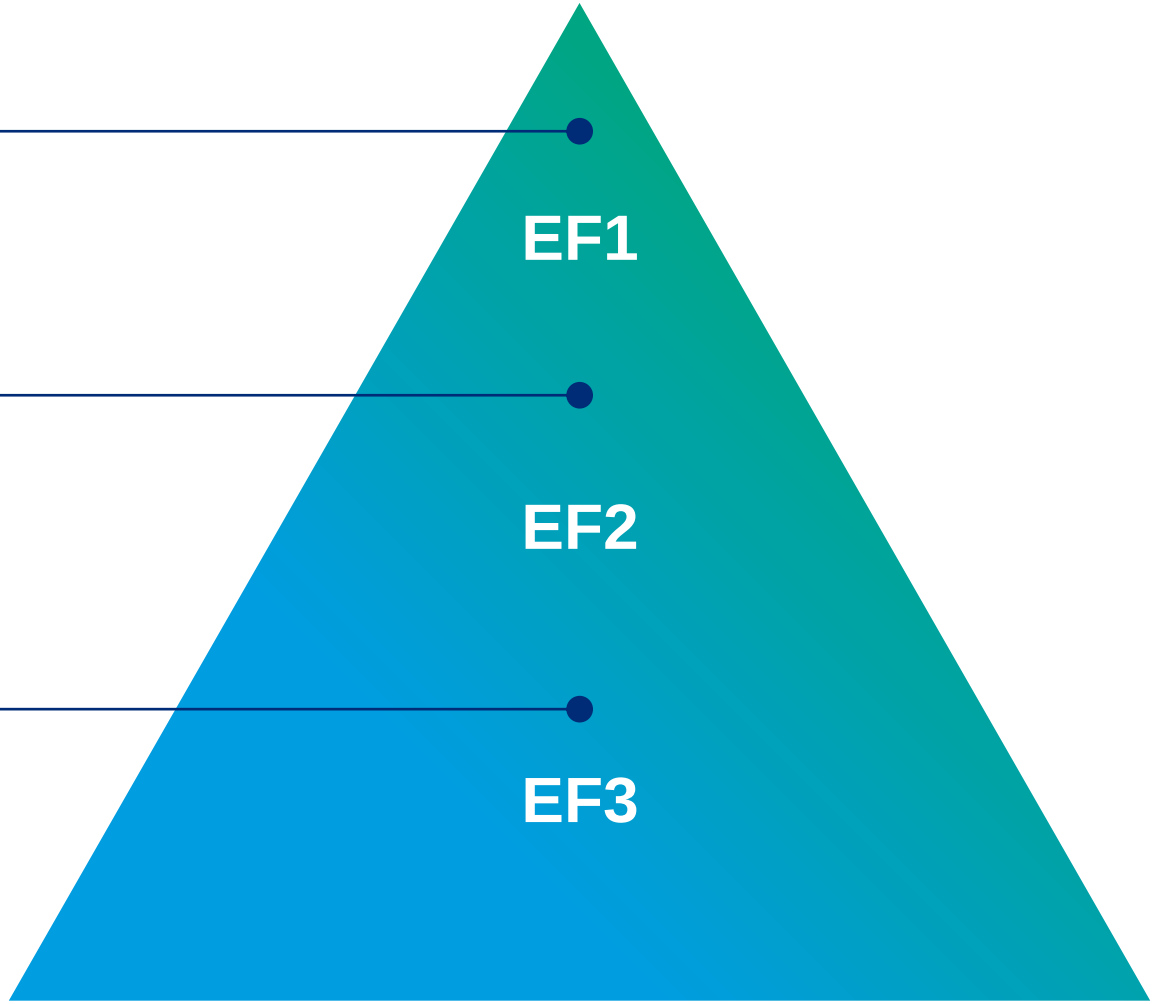
Liability Benchmark

- In order to evaluate financial risks and to find portfolios that will minimize them, we develop a fixed income portfolio that reproduces the fluctuations of the liabilities (called the Liability Benchmark)
- Based on information provided by Manitoba Public Insurance, the duration and the liability benchmark portfolios for Basic Insurance liabilities (unpaid claims) are summarized below:

	Basic Short	Basic Long
Duration	0.7 years	11.0 years
Liability Benchmark		
• Treasury Bills	85%	--
• Short Provincial Bonds	15%	36%
• Mid Provincial Bonds	---	2%
• Long Provincial Bonds	---	--
• Real Return Bonds	---	62%

Efficient Frontiers

Step-wise analysis



Efficient Frontier 1

- Provincial Bonds
- Non-Marketable Bonds
- Corporate Bonds
- **Real Return Bonds**

Efficient Frontier 2

- Provincial Bonds
- Non-Marketable Bonds
- Corporate Bonds
- Real Return Bonds
- **Commercial Mortgages**
- **Real Estate**

Efficient Frontier 3

- Provincial Bonds
- Non-Marketable Bonds
- **3x Long-Term Provincial Bonds**
- Corporate Bonds
- Real Return Bonds
- **3x Real Return Bonds**
- Commercial Mortgages
- Real Estate
- **Canadian Equity**
- **Global Equity***
- **All Country World Equity***

* While the model prefers ACWI equity to Global equity, we have tested the differences and the impact on risk and return are negligible. Therefore, while the asset mixes modelled make reference to ACWI equity (since that was the mathematically optimized result), replacing the allocations with Global equity would not materially change the result.

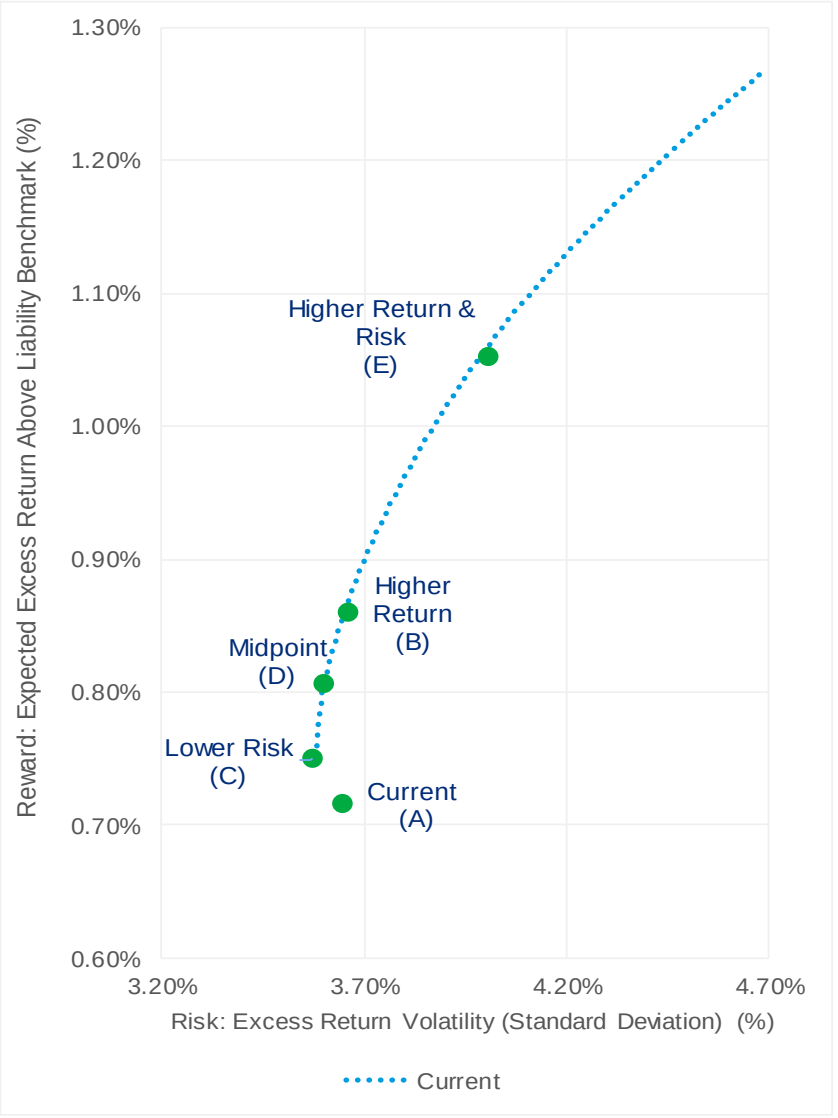
Efficient Frontiers

Basic Long

Efficient Frontiers (Minimally Constrained) – Basic Long

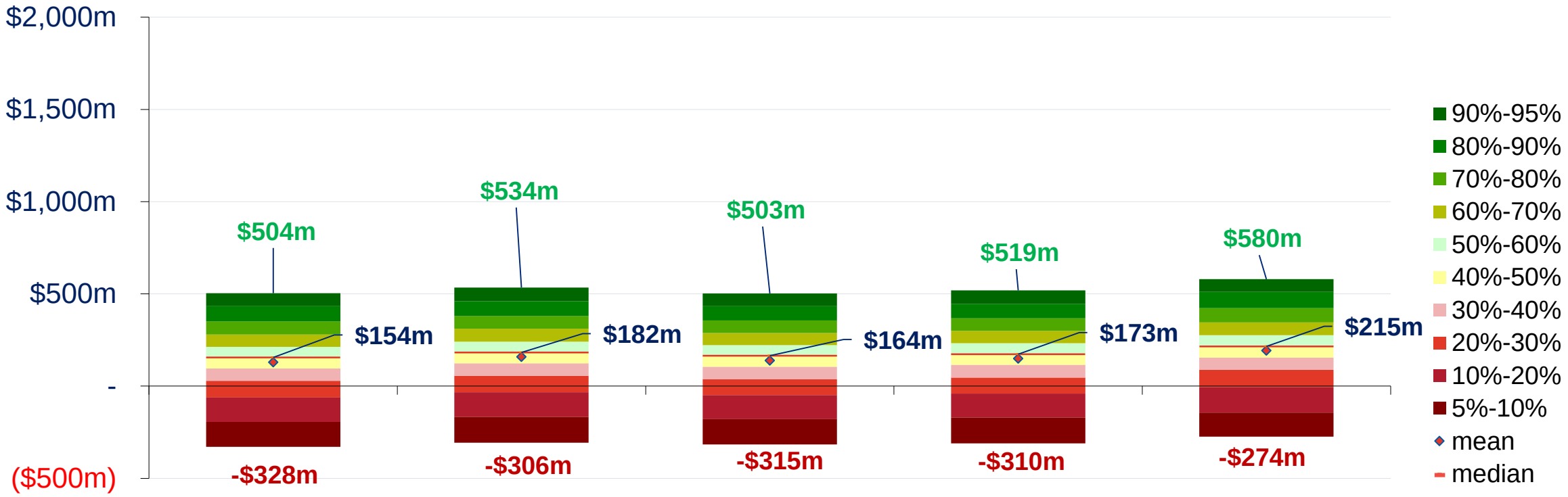
Current Asset Classes Only

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	100%	100%	100%	100%
3x Real Return Bonds	---	---	---	---	---	---
Real return bonds	62%	---	---	---	---	---
3x Long Provincial Bonds	---	---	---	---	---	---
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	13%	18%	10%	26%
Provincial long-term bonds	---	27%	28%	34%	35%	---
Corporate mid-term bonds	---	9%	29%	28%	35%	7%
Corporate long-term bonds	---	11%	10%	---	---	47%
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	--	--	--	--
Canadian equity (large cap.)	---	---	---	---	---	---
All Country World Equity	---	---	---	---	---	---
Alternatives	--	--	--	--	--	--
Commercial mortgages	---	---	---	---	---	---
Core Canadian Real Estate	---	---	---	---	---	---
Return Metrics						
Median return - 10 year	1.85%	2.48%	2.63%	2.52%	2.58%	2.82%
Risk Metrics						
Expected excess return - 10 year		0.72%	0.86%	0.75%	0.81%	1.05%
Surplus volatility		3.65%	3.66%	3.57%	3.60%	4.00%
Information Ratio (Excess Return/Risk)		0.20	0.24	0.21	0.22	0.26
5% Value at Risk		124.0 M	126.3 M	123.0 M	124.3 M	138.1 M
Probability of deficit - 10 year		26%	24%	25%	24%	21%
Other Metrics						
Minimum Capital Required		15.6 M	31.0 M	22.7 M	28.3 M	41.2 M
Interest Rate Metrics						
Duration	10.9	11.1	11.0	10.9	10.9	10.9
Hedge Ratio	100%	101%	100%	99%	100%	100%



Surplus Projections After 10 Years – Basic Long

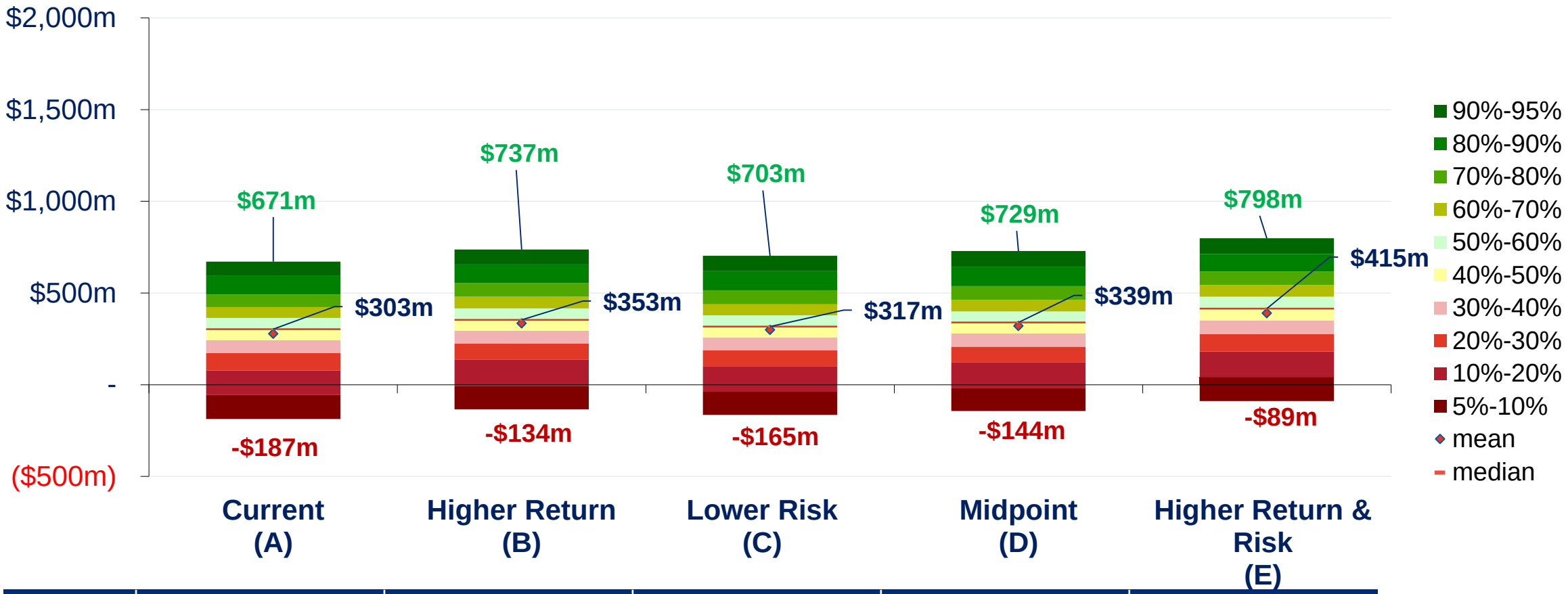
Current Asset Classes Only



Range					
5th-95th	$832m	$840m	$818m	$829m	$854m
5th-50th	$482m	$488m	$479m	$483m	$489m

Surplus Projections After 20 Years – Basic Long

Current Asset Classes Only

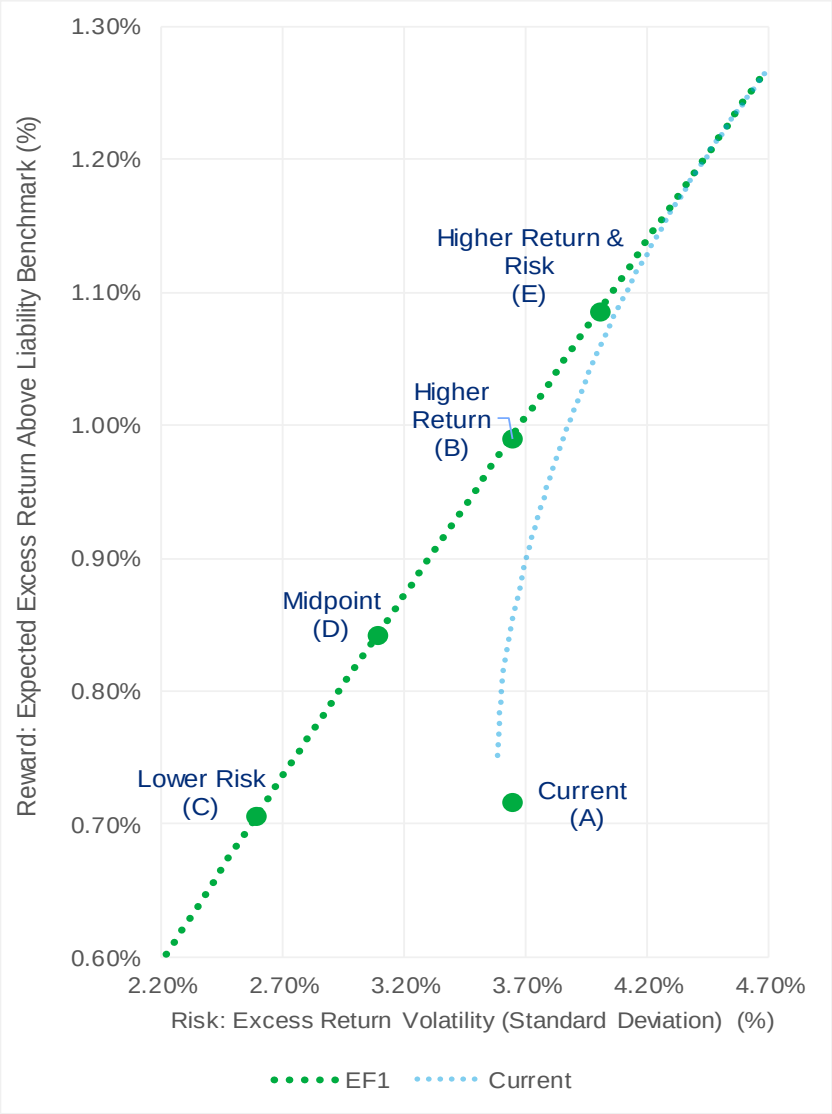


Range					
5th-95th	$858m	$871m	$868m	$873m	$887m
5th-50th	$490m	$487m	$482m	$483m	$504m

Efficient Frontiers (Minimally Constrained) – Basic Long

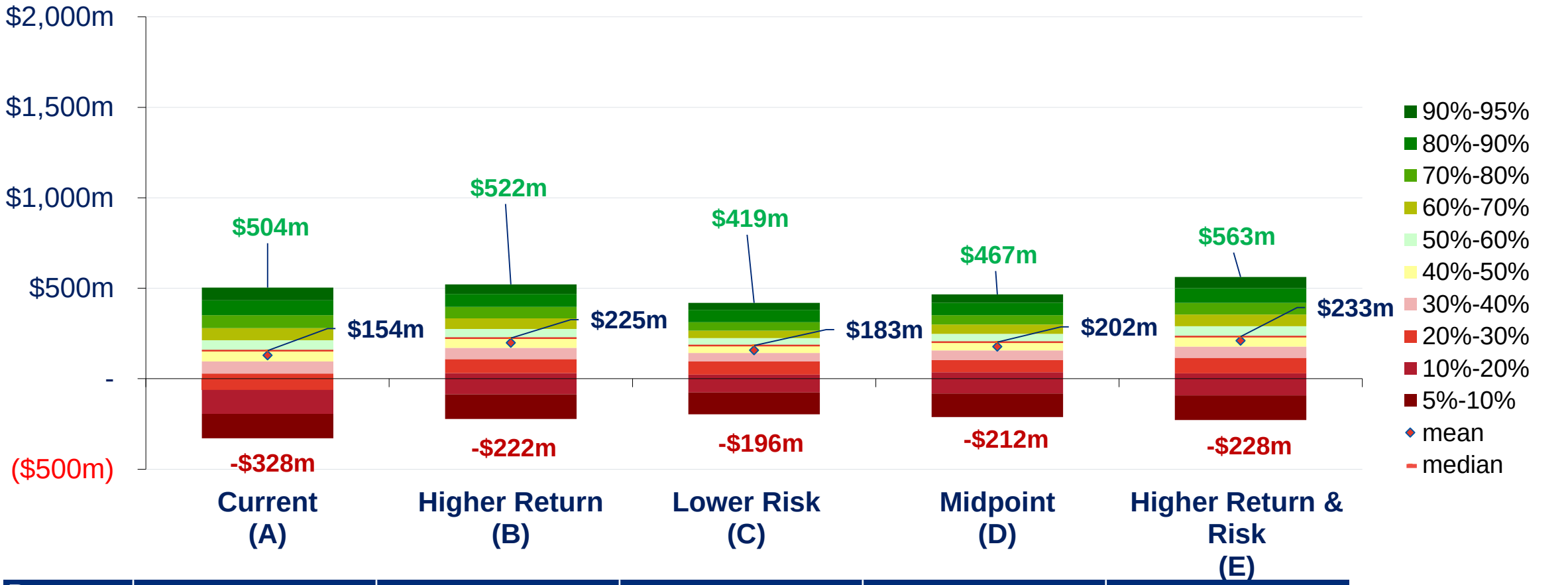
Adding Real Return Bonds

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	100%	100%	100%	100%
3x Real Return Bonds	---	---	---	---	---	---
Real return bonds	62%	---	13%	30%	22%	8%
3x Long Provincial Bonds	---	---	---	---	---	---
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	6%	6%	6%	5%
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	29%	32%	30%	28%
Corporate long-term bonds	---	11%	32%	12%	22%	39%
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	--	--	--	--
Canadian equity (large cap.)	---	---	---	---	---	---
All Country World Equity	---	---	---	---	---	---
Alternatives	--	--	--	--	--	--
Commercial mortgages	---	---	---	---	---	---
Core Canadian Real Estate	---	---	---	---	---	---
Return Metrics						
Median return - 10 year	1.85%	2.48%	2.77%	2.50%	2.63%	2.85%
Risk Metrics						
Expected excess return - 10 year		0.72%	0.99%	0.71%	0.84%	1.08%
Surplus volatility		3.65%	3.64%	2.59%	3.09%	4.01%
Information Ratio (Excess Return/Risk)		0.20	0.27	0.27	0.27	0.27
5% Value at Risk		124.0 M	127.0 M	91.9 M	108.6 M	138.6 M
Probability of deficit - 10 year		26%	17%	17%	16%	17%
Other Metrics						
Minimum Capital Required		15.6 M	47.7 M	35.0 M	40.9 M	52.1 M
Interest Rate Metrics						
Duration	10.9	11.1	10.9	11.0	11.0	10.9
Hedge Ratio	100%	101%	100%	100%	100%	100%



Surplus Projections After 10 Years – Basic Long

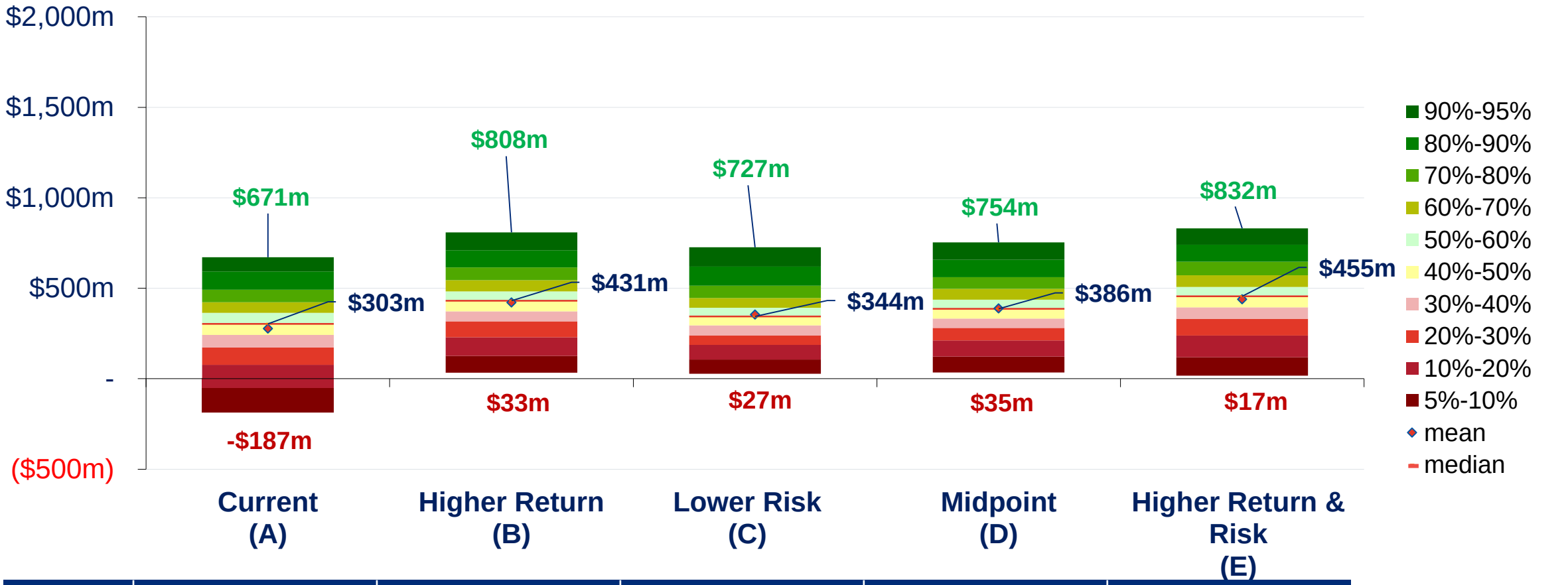
Adding Real Return Bonds



Range					
5th-95th	$832m	$744m	$615m	$679m	$791m
5th-50th	$482m	$447m	$379m	$414m	$461m

Surplus Projections After 20 Years – Basic Long

Adding Real Return Bonds

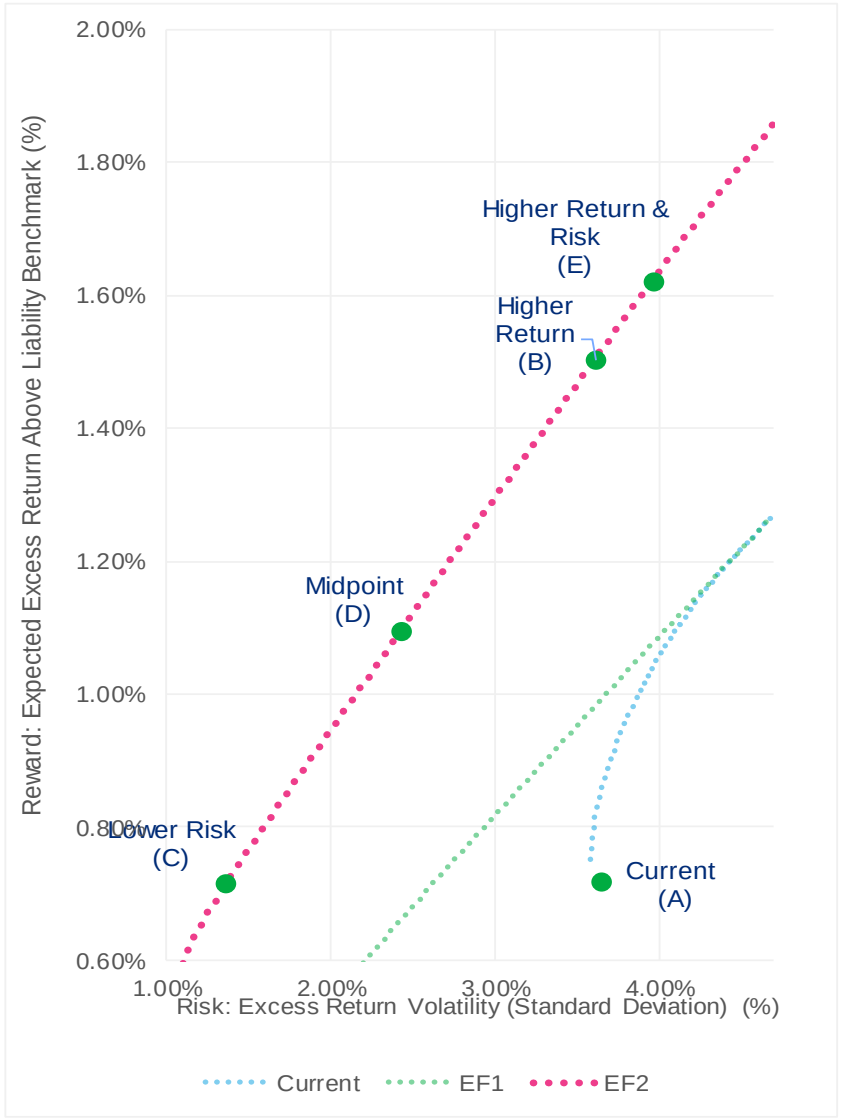


Range					
5th-95th	$858m	$775m	$700m	$719m	$815m
5th-50th	$490m	$398m	$317m	$351m	$438m

Efficient Frontiers (Minimally Constrained) – Basic Long

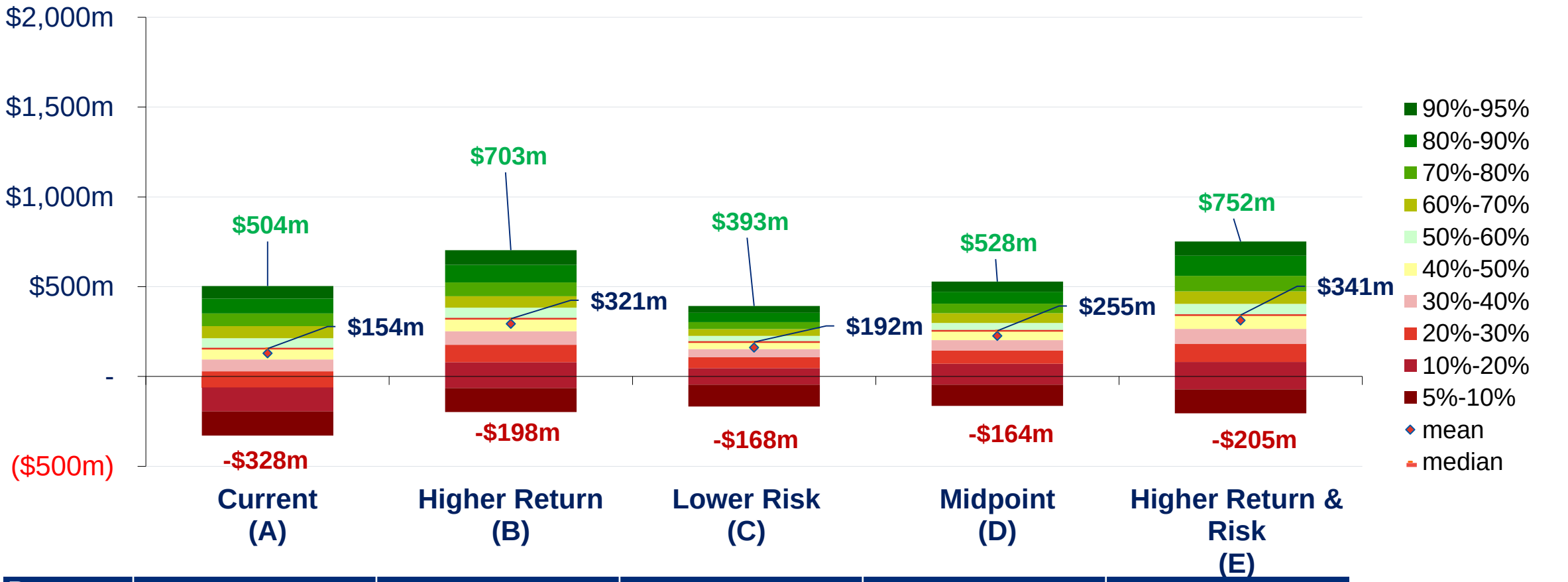
Adding Commercial Mortgages and Real Estate

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	85%	85%	85%	85%
3x Real Return Bonds	---	---	---	---	---	---
Real return bonds	62%	---	20%	46%	34%	16%
3x Long Provincial Bonds	---	---	---	---	---	---
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	1%	5%	3%	---
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	8%	14%	11%	7%
Corporate long-term bonds	---	11%	36%	---	17%	42%
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	--	--	--	--
Canadian equity (large cap.)	---	---	---	---	---	---
All Country World Equity	---	---	---	---	---	---
Alternatives	--	--	15%	15%	15%	15%
Commercial mortgages	---	---	1%	9%	5%	---
Core Canadian Real Estate	---	---	14%	6%	10%	15%
Return Metrics						
Median return - 10 year	1.85%	2.48%	3.31%	2.55%	2.92%	3.42%
Risk Metrics						
Expected excess return - 10 year		0.72%	1.50%	0.72%	1.09%	1.62%
Surplus volatility		3.65%	3.62%	1.36%	2.43%	3.97%
Information Ratio (Excess Return/Risk)		0.20	0.42	0.52	0.45	0.41
5% Value at Risk		124.0 M	133.5 M	62.8 M	95.8 M	144.4 M
Probability of deficit - 10 year		26%	13%	14%	13%	14%
Other Metrics						
Minimum Capital Required		15.6 M	92.5 M	53.9 M	72.4 M	98.2 M
Interest Rate Metrics						
Duration	10.9	11.1	10.9	10.9	10.9	11.0
Hedge Ratio	100%	101%	100%	100%	100%	100%



Surplus Projections After 10 Years – Basic Long

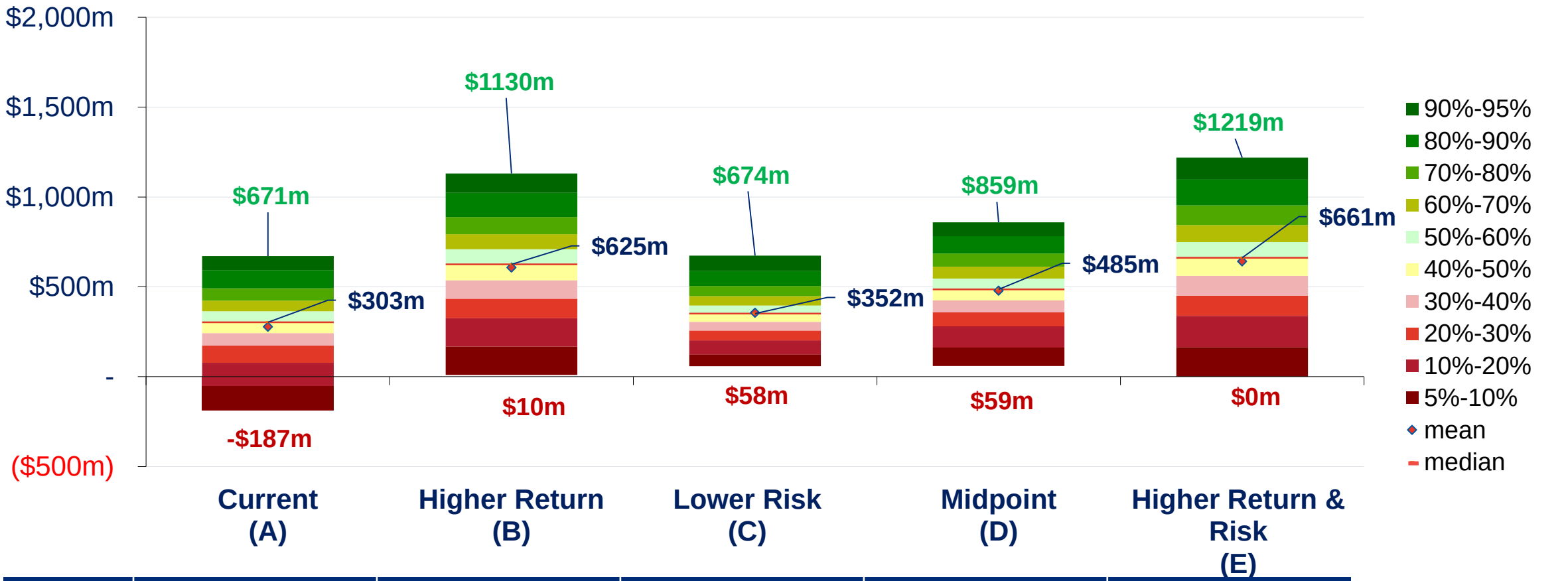
Adding Commercial Mortgages and Real Estate



Range					
5th-95th	$832m	$901m	$561m	$692m	$957m
5th-50th	$482m	$519m	$360m	$419m	$546m

Surplus Projections After 20 Years – Basic Long

Adding Commercial Mortgages and Real Estate

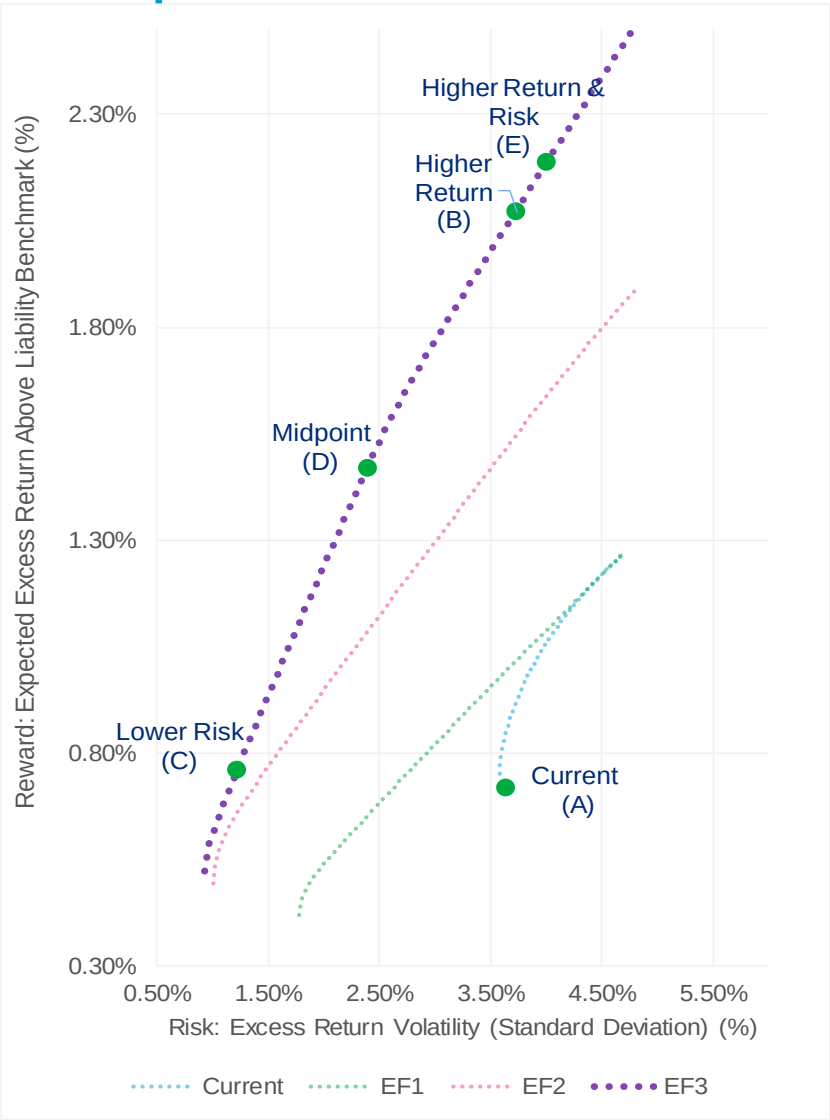


Range					
5th-95th	$858m	$1120m	$616m	$800m	$1219m
5th-50th	$490m	$615m	$294m	$426m	$661m

Efficient Frontiers (Minimally Constrained) – Basic Long

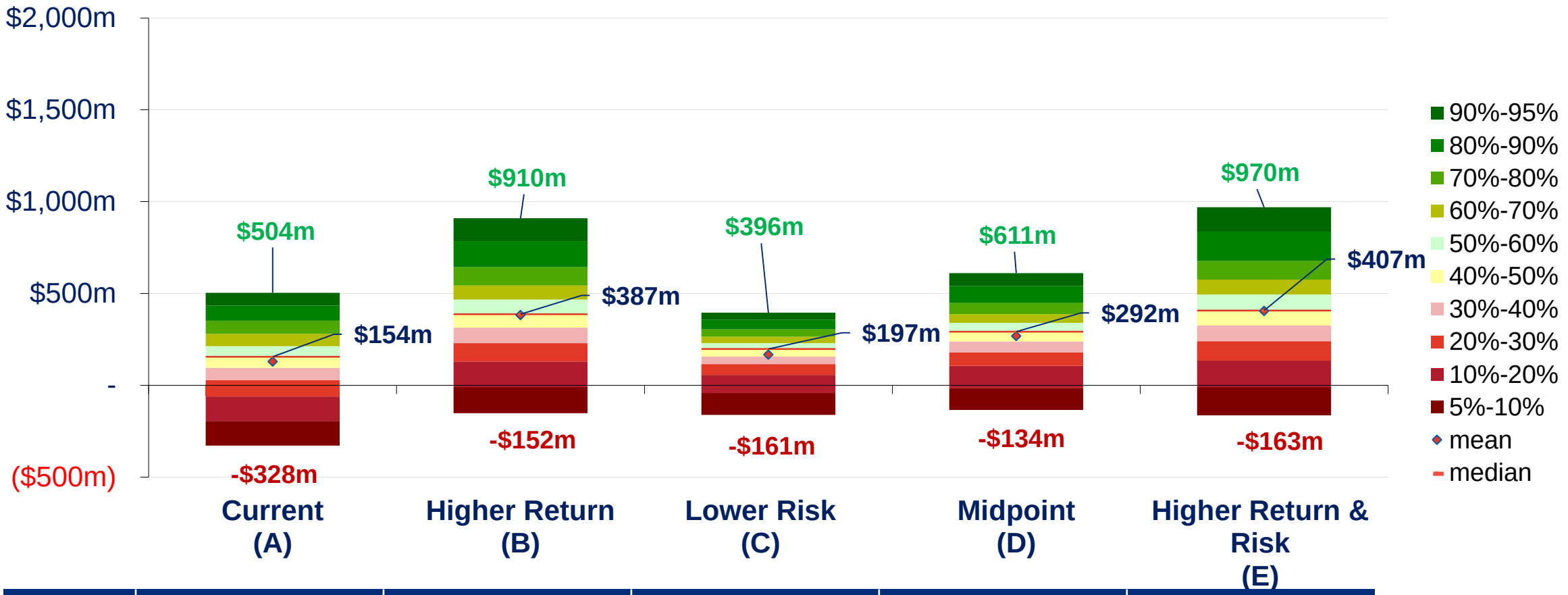
Adding 3x Long-Term Provincial Bonds, 3x Real Return Bonds and Equities

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	69%	81%	75%	68%
3x Real Return Bonds	---	---	9%	2%	12%	8%
Real return bonds	62%	---	---	38%	---	---
3x Long Provincial Bonds	---	---	4%	---	---	5%
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	33%	21%	43%	31%
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	3%	---	---	4%
Corporate long-term bonds	---	11%	---	---	---	---
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	16%	4%	10%	17%
Canadian equity (large cap.)	---	---	12%	4%	10%	13%
All Country World Equity	---	---	4%	---	---	4%
Alternatives	--	--	15%	15%	15%	15%
Commercial mortgages	---	---	4%	12%	9%	3%
Core Canadian Real Estate	---	---	11%	3%	6%	12%
Return Metrics						
Median return - 10 year	1.85%	2.48%	3.82%	2.58%	3.24%	3.93%
Probability of positive real return - 10 year		63%	82%	72%	79%	83%
Risk Metrics						
Expected excess return - 10 year		0.72%	2.07%	0.76%	1.47%	2.19%
Surplus volatility		3.65%	3.73%	1.22%	2.41%	4.01%
Information Ratio (Excess Return/Risk)		0.20	0.55	0.62	0.61	0.54
5% Value at Risk		124.0 M	122.4 M	52.9 M	74.7 M	132.1 M
Probability of deficit - 10 year		26%	11%	14%	11%	11%
Other Metrics						
Minimum Capital Required		15.6 M	160.5 M	60.8 M	103.3 M	169.4 M
Interest Rate Metrics						
Duration	10.9	11.1	11.0	10.9	11.1	10.9
Hedge Ratio	100%	101%	100%	100%	101%	100%



Surplus Projections After 10 Years – Basic Long

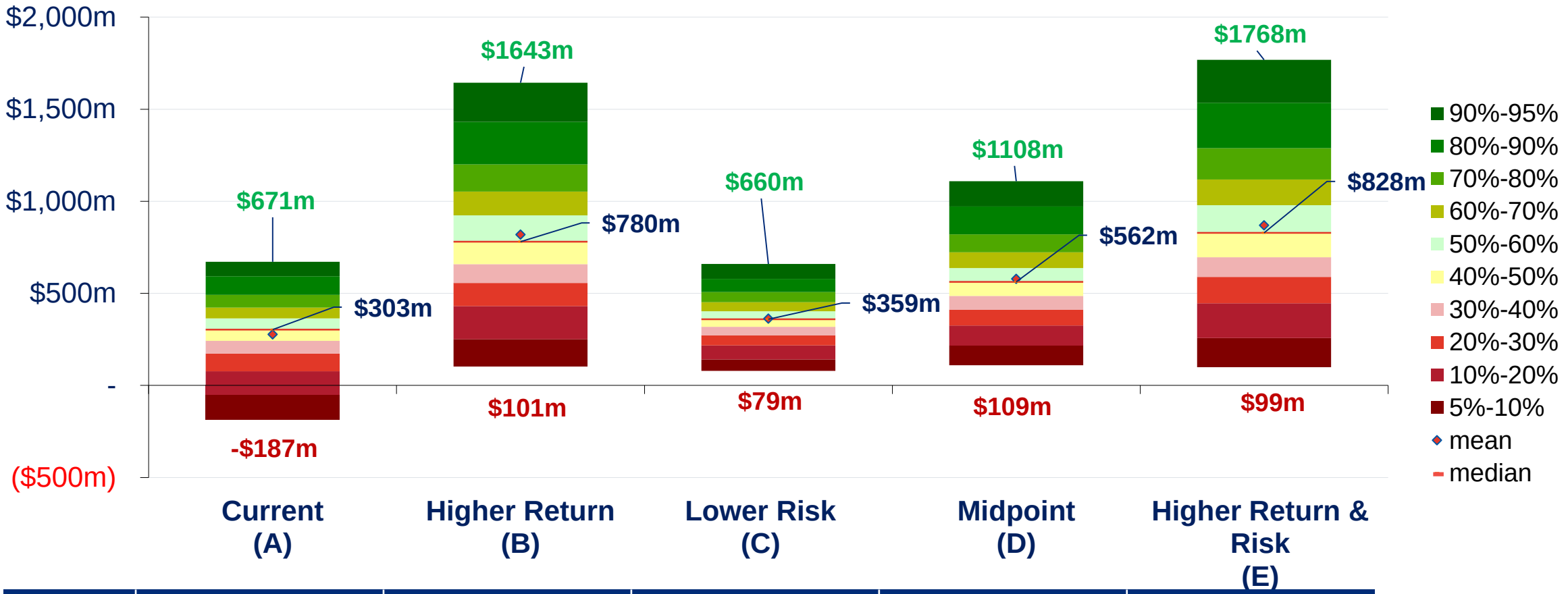
Adding 3x Long-Term Provincial Bonds, 3x Real Return Bonds and Equities



Range					
5th-95th	$832m	$1062m	$557m	$745m	$1133m
5th-50th	$482m	$539m	$358m	$426m	$570m

Surplus Projections After 20 Years – Basic Long

Adding 3x Long-Term Provincial Bonds, 3x Real Return Bonds and Equities



Range					
5th-95th	$858m	$1542m	$581m	$999m	$1669m
5th-50th	$490m	$679m	$280m	$453m	$729m

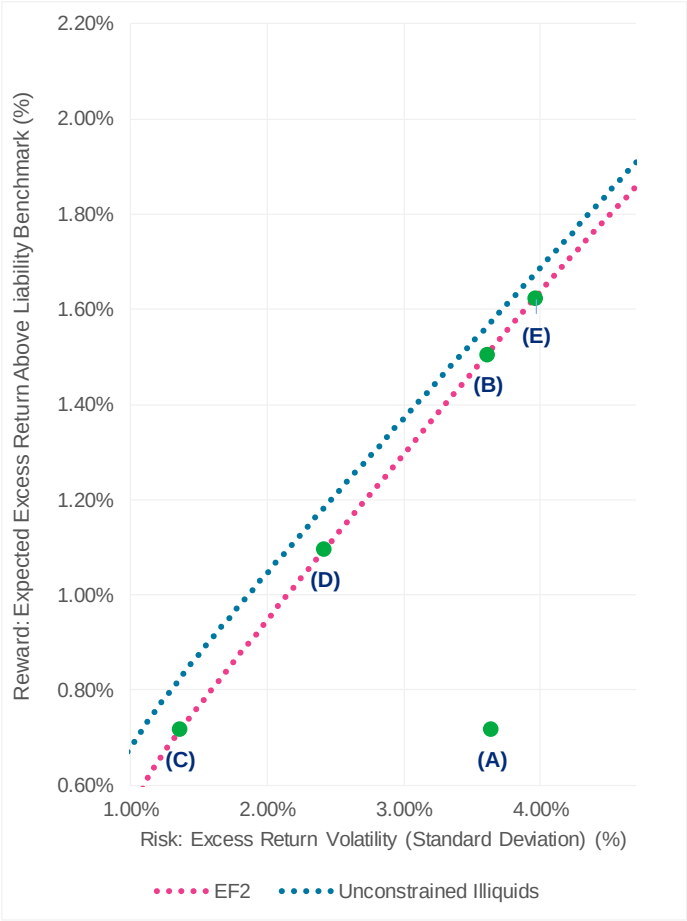
Efficient Frontiers

Cost of Constraints - Basic Long

Efficient Frontiers – Basic Long

Cost of Constraint Analysis vs. EF2: Illiquid Constraint Only

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	85%	85%	85%	85%
3x Real Return Bonds	---	---	---	---	---	---
Real return bonds	62%	---	20%	46%	34%	16%
3x Long Provincial Bonds	---	---	---	---	---	---
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	1%	5%	3%	---
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	8%	14%	11%	7%
Corporate long-term bonds	---	11%	36%	---	17%	42%
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	--	--	--	--
Canadian equity (large cap.)	---	---	---	---	---	---
All Country World Equity	---	---	---	---	---	---
Alternatives	--	--	15%	15%	15%	15%
Commercial mortgages	---	---	1%	9%	5%	---
Core Canadian Real Estate	---	---	14%	6%	10%	15%
Return Metrics						
Median return - 10 year	1.85%	2.48%	3.31%	2.55%	2.92%	3.42%
Risk Metrics						
Expected excess return - 10 year		0.72%	1.50%	0.72%	1.09%	1.62%
Surplus volatility		3.65%	3.62%	1.36%	2.43%	3.97%
Information Ratio (Excess Return/Risk)		0.20	0.42	0.52	0.45	0.41
5% Value at Risk		124.0 M	133.5 M	62.8 M	95.8 M	144.4 M
Other Metrics						
Minimum Capital Required		15.6 M	92.5 M	53.9 M	72.4 M	98.2 M
Interest Rate Metrics						
Duration	10.9	11.1	10.9	10.9	10.9	11.0
Hedge Ratio	100%	101%	100%	100%	100%	100%



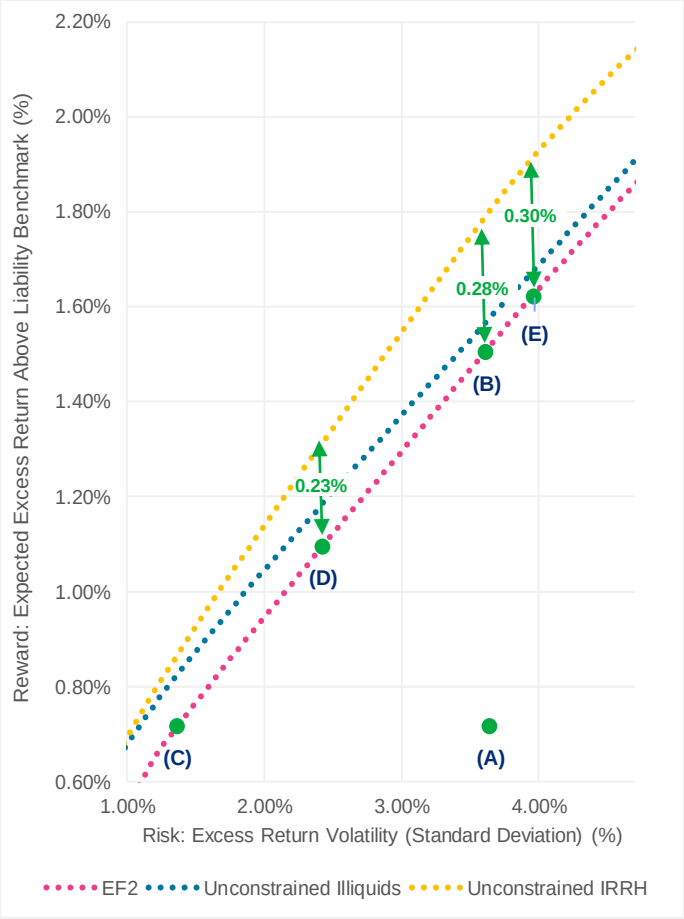
Cost of constraint analysis:

- The "Unconstrained Illiquids" frontier shows a slight improvement in risk/return metrics compared to EF2 due to:
  - Higher allocations to alternative asset classes which benefit from an illiquidity premium; and
  - Greater diversification
- Removing the illiquid constraint results in approximately 5-10bp improvement in expected return for the same level of risk

Efficient Frontiers – Basic Long

Cost of Constraint Analysis vs. EF2: Illiquid and IRRH Constraints

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	85%	85%	85%	85%
3x Real Return Bonds	---	---	---	---	---	---
Real return bonds	62%	---	20%	46%	34%	16%
3x Long Provincial Bonds	---	---	---	---	---	---
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	1%	5%	3%	---
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	8%	14%	11%	7%
Corporate long-term bonds	---	11%	36%	---	17%	42%
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	--	--	--	--
Canadian equity (large cap.)	---	---	---	---	---	---
All Country World Equity	---	---	---	---	---	---
Alternatives	--	--	15%	15%	15%	15%
Commercial mortgages	---	---	1%	9%	5%	---
Core Canadian Real Estate	---	---	14%	6%	10%	15%
Return Metrics						
Median return - 10 year	1.85%	2.48%	3.31%	2.55%	2.92%	3.42%
Risk Metrics						
Expected excess return - 10 year		0.72%	1.50%	0.72%	1.09%	1.62%
Surplus volatility		3.65%	3.62%	1.36%	2.43%	3.97%
Information Ratio (Excess Return/Risk)		0.20	0.42	0.52	0.45	0.41
5% Value at Risk		124.0 M	133.5 M	62.8 M	95.8 M	144.4 M
Other Metrics						
Minimum Capital Required		15.6 M	92.5 M	53.9 M	72.4 M	98.2 M
Interest Rate Metrics						
Duration	10.9	11.1	10.9	10.9	10.9	11.0
Hedge Ratio	100%	101%	100%	100%	100%	100%



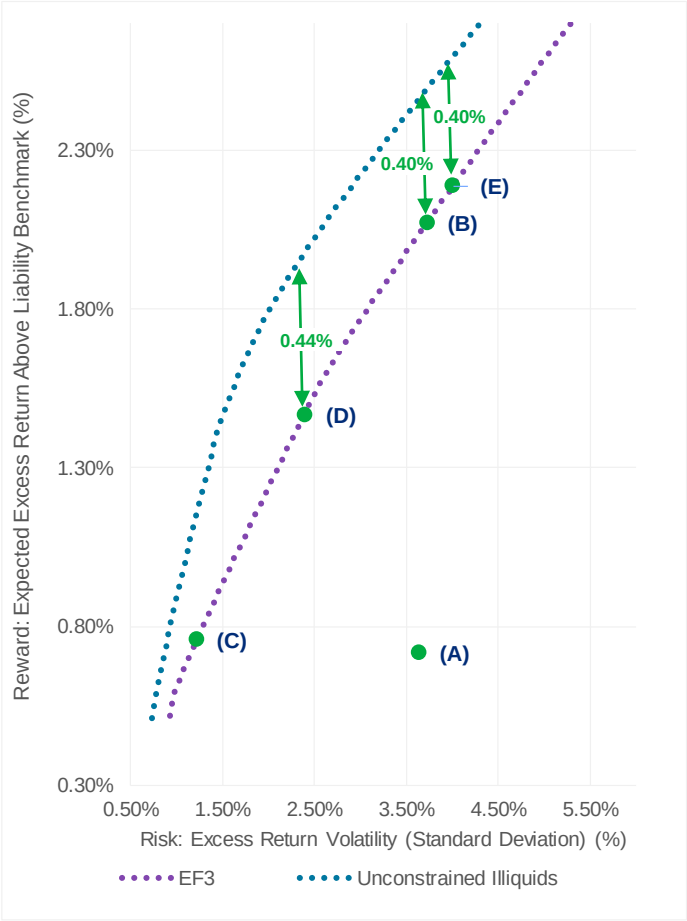
Cost of constraint analysis:

- Building on the removal of illiquidity constraints, removing the 100% interest rate hedge ratio constraint further shifts the efficient frontier ("Unconstrained IRRH") upwards
- The impact is minimal at lower risk mixes, such as Mix C
- For higher risk mixes, such as Mix E, the impact is an increase in expected return of approximately 30bps for the same level of risk (compared to the minimally constrained EF2)

Efficient Frontiers – Basic Long

Cost of Constraint Analysis vs. EF3: Illiquid Constraint Only

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	69%	81%	75%	68%
3x Real Return Bonds	---	---	9%	2%	12%	8%
Real return bonds	62%	---	---	38%	---	---
3x Long Provincial Bonds	---	---	4%	---	---	5%
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	33%	21%	43%	31%
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	3%	---	---	4%
Corporate long-term bonds	---	11%	---	---	---	---
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	16%	4%	10%	17%
Canadian equity (large cap.)	---	---	12%	4%	10%	13%
All Country World Equity	---	---	4%	---	---	4%
Alternatives	--	--	15%	15%	15%	15%
Commercial mortgages	---	---	4%	12%	9%	3%
Core Canadian Real Estate	---	---	11%	3%	6%	12%
Return Metrics						
Median return - 10 year	1.85%	2.48%	3.82%	2.58%	3.24%	3.93%
Risk Metrics						
Expected excess return - 10 year		0.72%	2.07%	0.76%	1.47%	2.19%
Surplus volatility		3.65%	3.73%	1.22%	2.41%	4.01%
Information Ratio (Excess Return/Risk)		0.20	0.55	0.62	0.61	0.54
5% Value at Risk		124.0 M	122.4 M	52.9 M	74.7 M	132.1 M
Other Metrics						
Minimum Capital Required		15.6 M	160.5 M	60.8 M	103.3 M	169.4 M
Interest Rate Metrics						
Duration	10.9	11.1	11.0	10.9	11.1	10.9
Hedge Ratio	100%	101%	100%	100%	101%	100%



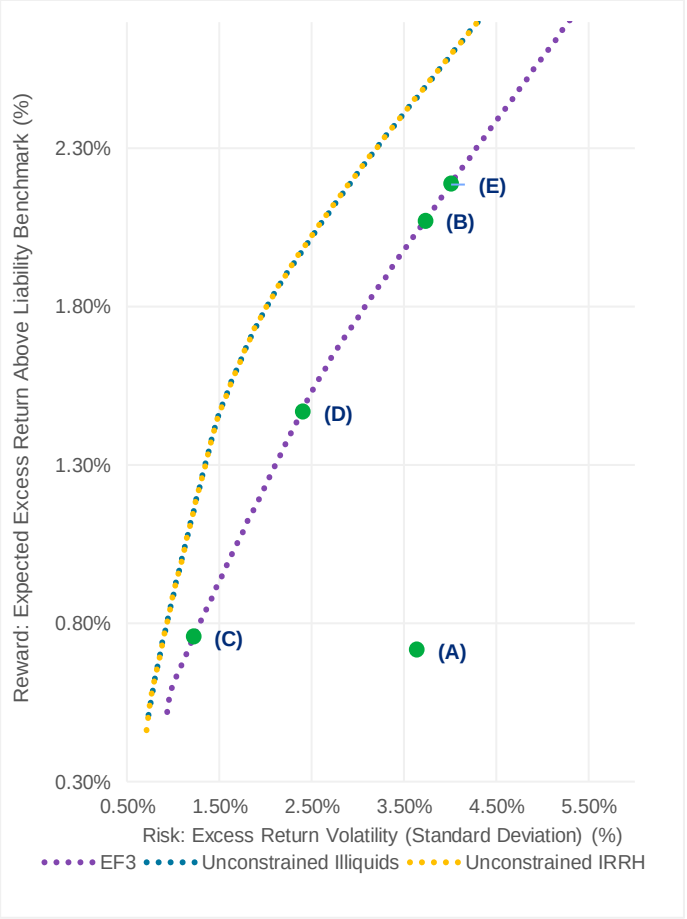
Cost of constraint analysis:

- The "Unconstrained Illiquids" frontier shows a significant improvement in risk/return metrics for mixes B, D, and E compared to EF3
  - Removing the illiquid constraint results in approximately 40-50bp improvement in expected return for the same level of risk
- For lower risk mixes, the improvement from removing the illiquid constraint is less significant (approx. 20-30bps)

Efficient Frontiers – Basic Long

Cost of Constraint Analysis vs. EF3: Illiquid and IRRH Constraints

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	69%	81%	75%	68%
3x Real Return Bonds	---	---	9%	2%	12%	8%
Real return bonds	62%	---	---	38%	---	---
3x Long Provincial Bonds	---	---	4%	---	---	5%
Provincial short-term bonds	36%	---	---	---	---	---
Provincial mid-term bonds	2%	33%	33%	21%	43%	31%
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	3%	---	---	4%
Corporate long-term bonds	---	11%	---	---	---	---
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	16%	4%	10%	17%
Canadian equity (large cap.)	---	---	12%	4%	10%	13%
All Country World Equity	---	---	4%	---	---	4%
Alternatives	--	--	15%	15%	15%	15%
Commercial mortgages	---	---	4%	12%	9%	3%
Core Canadian Real Estate	---	---	11%	3%	6%	12%
Return Metrics						
Median return - 10 year	1.85%	2.48%	3.82%	2.58%	3.24%	3.93%
Risk Metrics						
Expected excess return - 10 year		0.72%	2.07%	0.76%	1.47%	2.19%
Surplus volatility		3.65%	3.73%	1.22%	2.41%	4.01%
Information Ratio (Excess Return/Risk)		0.20	0.55	0.62	0.61	0.54
5% Value at Risk		124.0 M	122.4 M	52.9 M	74.7 M	132.1 M
Other Metrics						
Minimum Capital Required		15.6 M	160.5 M	60.8 M	103.3 M	169.4 M
Interest Rate Metrics						
Duration	10.9	11.1	11.0	10.9	11.1	10.9
Hedge Ratio	100%	101%	100%	100%	101%	100%



Cost of constraint analysis:

- Building on the removal of illiquidity constraints, removing the 100% interest rate hedge ratio constraint ("Unconstrained IRRH") has virtually no additional improvement in expected return at the level of risk that is being considered.
    - Levered bonds are favoured by the analysis at lower risk mixes even if the constraint is removed, demonstrating their capital-efficient approach to hedging risk

Efficient Frontiers

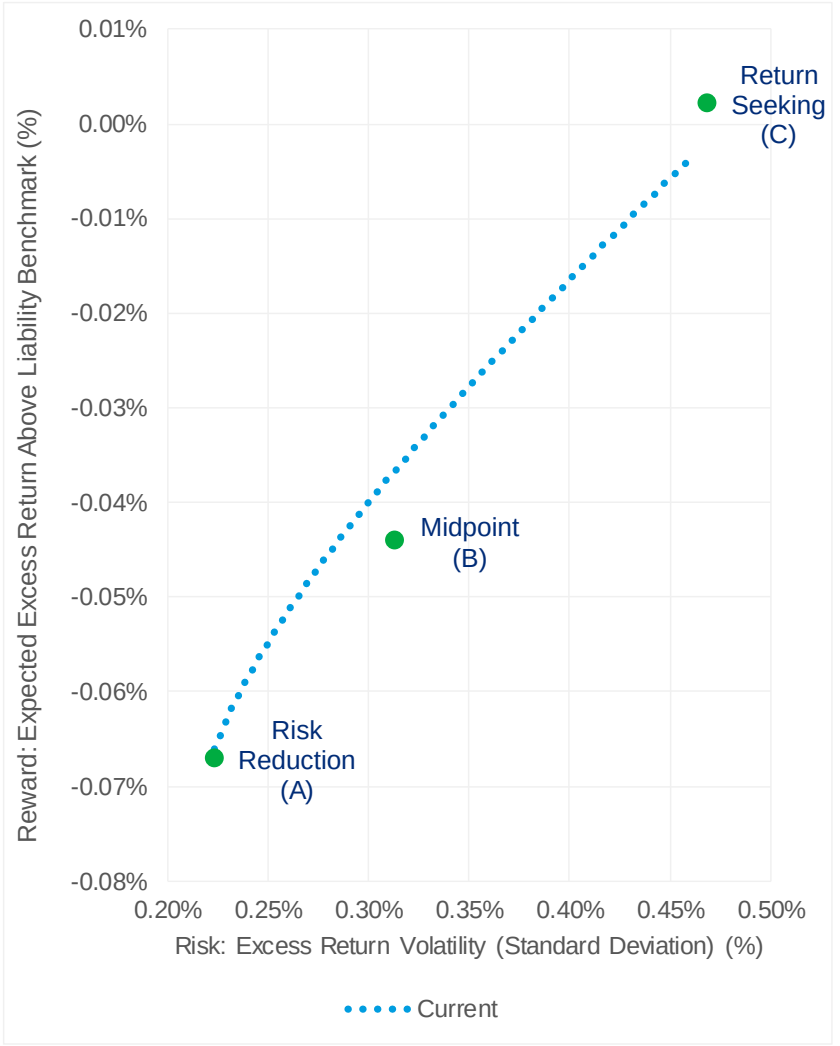
Basic Short

4

Efficient Frontiers (Minimally Constrained) – Basic Short

Current Asset Classes Only

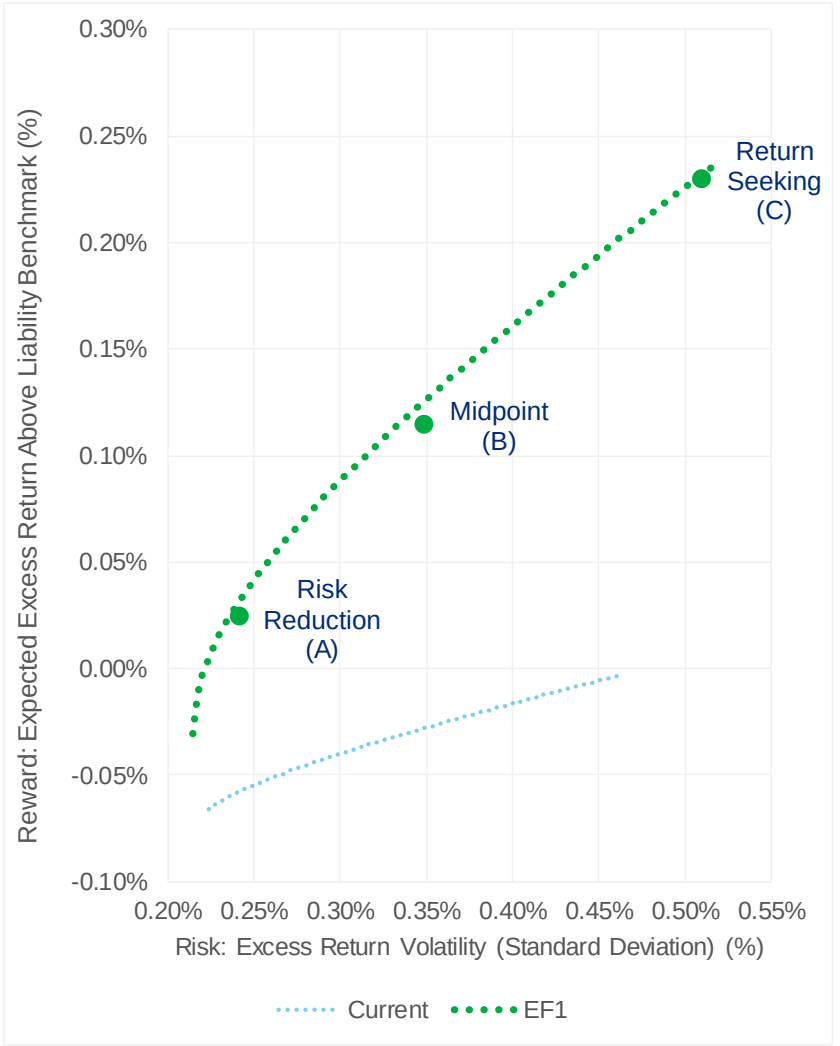
	Liability Benchmark	Current	Risk Reduction (A)	Midpoint (B)	Return Seeking (C)
Fixed Income	100%	100%	100%	100%	100%
Treasury Bills	85%	---	94%	94%	93%
Real return bonds	---	---	---	---	---
3x Long Provincial Bonds	---	---	---	---	---
Provincial short-term bonds	15%	---	---	---	---
Provincial mid-term bonds	---	33%	6%	3%	---
Provincial long-term bonds	---	27%	---	---	---
Corporate mid-term bonds	---	9%	---	3%	7%
Corporate long-term bonds	---	11%	---	---	---
MUSH Bonds	---	20%	---	---	---
Public Equities	--	--	--	--	--
Canadian equity (large cap.)	---	---	---	---	---
All Country World Equity	---	---	---	---	---
Alternatives	--	--	--	--	--
Commercial mortgages	---	---	---	---	---
Core Canadian Real Estate	---	---	---	---	---
Return Metrics					
Median return - 10 year	1.02%	2.48%	0.95%	0.98%	1.02%
Risk Metrics					
Expected excess return - 10 year		1.68%	-0.07%	-0.04%	0.00%
Surplus volatility		6.59%	0.22%	0.31%	0.47%
Other Metrics					
Minimum Capital Required		1.2 M	-	0.2 M	0.4 M
Interest Rate Metrics					
Duration	0.65		0.65	0.63	0.66
Hedge Ratio	100%		101%	97%	103%



Efficient Frontiers (Minimally Constrained) – Basic Short

Adding Commercial Mortgages

	Liability Benchmark	Current	Risk Reduction (A)	Midpoint (B)	Return Seeking (C)
Fixed Income	100%	100%	95%	90%	84%
Treasury Bills	85%	---	91%	88%	84%
Real return bonds	---	---	---	---	---
3x Long Provincial Bonds	---	---	---	---	---
Provincial short-term bonds	15%	---	---	---	---
Provincial mid-term bonds	---	33%	4%	2%	---
Provincial long-term bonds	---	27%	---	---	---
Corporate mid-term bonds	---	9%	---	---	---
Corporate long-term bonds	---	11%	---	---	---
MUSH Bonds	---	20%	---	---	---
Public Equities	--	--	--	--	--
Canadian equity (large cap.)	---	---	---	---	---
All Country World Equity	---	---	---	---	---
Alternatives	--	--	5%	10%	16%
Commercial mortgages	---	---	5%	10%	16%
Core Canadian Real Estate	---	---	---	---	---
Return Metrics					
Median return - 10 year	1.02%	2.48%	1.04%	1.13%	1.25%
Risk Metrics					
Expected excess return - 10 year		1.68%	0.02%	0.11%	0.23%
Surplus volatility		6.59%	0.24%	0.35%	0.51%
Other Metrics					
Minimum Capital Required		1.2 M	0.8 M	1.5 M	2.4 M
Interest Rate Metrics					
Duration	0.65		0.64	0.63	0.64
Hedge Ratio	100%		99%	97%	100%



Efficient Frontiers

Basic Combined

5

Efficient Frontiers

Basic Combined

- Following the March 28th meeting, MPI requested an analysis combining the Basic Short and Basic Long assets and liabilities
- Mercer's approach is as follows:

Step 1 – Re-Determined Liability Benchmark

	Basic Short	Basic Long	Combined
Duration	0.7 years	11.0 years	10.3 years
Liability Benchmark			
• Treasury Bills	85%	--	3%
• Short Provincial Bonds	15%	36%	39%
• Mid Provincial Bonds	---	2%	--
• Long Provincial Bonds	---	--	--
• Real Return Bonds	---	62%	58%

Step 2 – Adjusted asset mix construction based on weighted liabilities

- About 93% Long and 7% Short.
- Assumed *Midpoint (Mix B)* from the Basic Short analysis
- Constraints were maintained (i.e. 20% allocation to MUSH; max. 35% illiquid assets)

Step 3 – Refined asset mixes to optimize risk/return metrics

- Asset mixes refined to:
  - maintain 100% interest rate hedge ratio
  - align with risk/return spectrum from the Basic Long & Basic Short analysis

Efficient Frontiers (Minimally Constrained)

Basic Combined

	Liability Benchmark	Current (A)	Higher Return (B)	Lower Risk (C)	Midpoint (D)	Higher Return & Risk (E)
Fixed Income	100%	100%	70%	81%	76%	69%
Treasury Bills	3%	---	6%	6%	6%	6%
3x Real Return Bonds	---	---	8%	2%	11%	7%
Real return bonds	58%	---	---	35%	---	---
3x Long Provincial Bonds	---	---	4%	---	---	5%
Provincial short-term bonds	39%	---	---	---	---	---
Provincial mid-term bonds	---	33%	29%	18%	39%	27%
Provincial long-term bonds	---	27%	---	---	---	---
Corporate mid-term bonds	---	9%	3%	---	---	4%
Corporate long-term bonds	---	11%	---	---	---	---
MUSH Bonds	---	20%	20%	20%	20%	20%
Public Equities	--	--	15%	4%	9%	16%
Canadian equity (large cap.)	---	---	11%	4%	9%	12%
All Country World Equity	---	---	4%	---	---	4%
Alternatives	--	--	15%	15%	15%	15%
Commercial mortgages	---	---	5%	12%	9%	4%
Core Canadian Real Estate	---	---	10%	3%	6%	11%
Return Metrics						
Median return - 10 year	1.82%	2.48%	3.66%	2.52%	3.11%	3.77%
Risk Metrics						
Expected excess return - 10 year		0.76%	1.98%	0.73%	1.41%	2.10%
Surplus volatility		3.69%	3.52%	1.22%	2.26%	3.80%
Information Ratio (Excess Return/Risk)		0.21	0.56	0.60	0.62	0.55
5% Value at Risk		129.0 M	125.5 M	56.3 M	76.9 M	136.0 M
Other Metrics						
Minimum Capital Required		16.8 M	163.9 M	65.4 M	104.6 M	173.4 M
Interest Rate Metrics						
Duration	10.3	11.1	10.3	10.3	10.3	10.2
Hedge Ratio	100%	108%	100%	100%	101%	100%

Basic Short Allocation to T-bills[1]		Basic Short Proportion of liabilities		Basic Combined Allocation to T-Bills
88%	X	**7%**	=	**6%**

Maintained:
20% MUSH, and
15% Alternatives

Compared to **Current**:

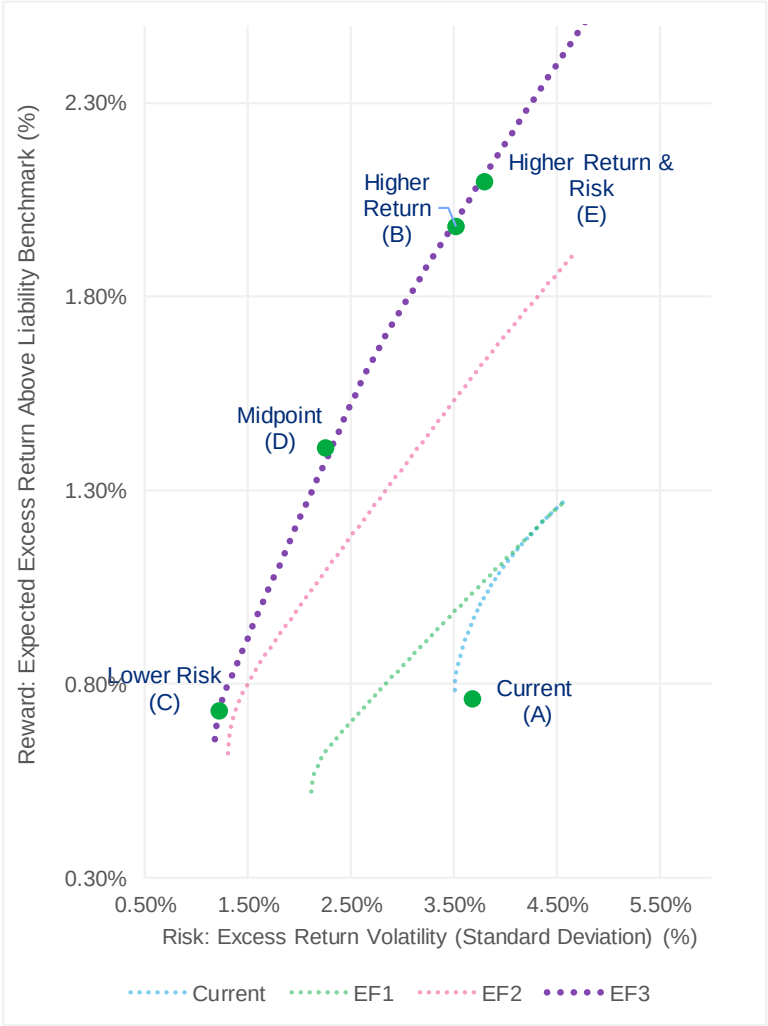
1. Median Returns are all higher
2. Information Ratios are all higher
3. 5% VaR are all lower, except (E)
4. MCTs are all higher

[1]Assumed Midpoint (Mix B) from Basic Short analysis on slide 17, given Basic Short has 3 mixes and Basic Long has 4 mixes.

Efficient Frontiers (Minimally Constrained)

Basic Combined

(A)	(B)	(C)	(D)	(E)
---	6%	6%	6%	6%
---	8%	2%	11%	7%
---	---	35%	---	---
---	4%	---	---	5%
---	---	---	---	---
33%	29%	18%	39%	27%
27%	---	---	---	---
9%	3%	---	---	4%
11%	---	---	---	---
20%	20%	20%	20%	20%
---	11%	4%	9%	12%
---	4%	---	---	4%
---	5%	12%	9%	4%
---	10%	3%	6%	11%
2.48%	3.66%	2.52%	3.11%	3.77%
0.76%	1.98%	0.73%	1.41%	2.10%
3.69%	3.52%	1.22%	2.26%	3.80%
0.21	0.56	0.60	0.62	0.55
not run	not run	not run	not run	not run
16.8 M	163.9 M	65.4 M	104.6 M	173.4 M
11.1	10.3	10.3	10.3	10.2
108%	100%	100%	101%	100%



- The combined mixes from the previous page are shown in the top left efficient frontier.
- The results show that the combined mixes are “efficient”.
  - Conducting the analysis on a separate basis vs. combined basis did not alter the efficiency of the mixes.

Appendix

Capital Market Assumptions

Capital Market Assumptions

As at December 31, 2021

	Asset Class	Median 10 year return	Standard deviation	Correlations 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Treasury Bills	0.9%	1.5%	1.00	(0.05)	0.33	0.11	(0.00)	0.09	(0.17)	(0.23)	(0.08)	(0.26)	(0.24)	(0.21)	(0.30)	(0.05)	0.07	0.31	0.17	(0.29)	(0.33)
2	Real return bonds	1.7%	7.5%	(0.05)	1.00	0.40	0.67	0.76	0.53	0.66	0.70	0.26	0.06	0.15	0.28	0.08	0.28	0.35	0.01	0.41	0.03	0.32
3	Provincial short-term bonds	1.9%	3.5%	0.33	0.40	1.00	0.88	0.61	0.75	0.45	0.29	(0.40)	(0.27)	0.04	(0.37)	(0.30)	(0.23)	0.19	(0.21)	0.56	(0.33)	0.21
4	Provincial mid-term bonds	2.2%	6.5%	0.11	0.67	0.88	1.00	0.88	0.75	0.68	0.62	(0.23)	(0.13)	0.27	(0.21)	(0.16)	(0.09)	0.25	(0.13)	0.45	(0.12)	0.35
5	Provincial long-term bonds	2.3%	8.5%	(0.00)	0.76	0.61	0.88	1.00	0.58	0.70	0.79	0.00	0.09	0.39	0.01	0.02	0.11	0.24	(0.01)	0.28	0.04	0.36
6	Corporate short-term bonds	2.5%	3.5%	0.09	0.53	0.75	0.75	0.58	1.00	0.86	0.65	0.09	0.07	0.20	0.15	0.10	0.21	0.24	(0.29)	0.65	0.17	0.48
7	Corporate mid-term bonds	3.0%	6.5%	(0.17)	0.66	0.45	0.68	0.70	0.86	1.00	0.92	0.31	0.24	0.39	0.34	0.28	0.37	0.22	(0.19)	0.45	0.42	0.59
8	Corporate long-term bonds	3.3%	8.5%	(0.23)	0.70	0.29	0.62	0.79	0.65	0.92	1.00	0.35	0.28	0.43	0.36	0.30	0.41	0.19	(0.07)	0.25	0.46	0.54
9	Canadian equity (large cap.)	5.7%	19.5%	(0.08)	0.26	(0.40)	(0.23)	0.00	0.09	0.31	0.35	1.00	0.68	0.31	0.90	0.73	0.78	0.21	0.16	0.01	0.62	0.14
10	Global equity (large cap.)	5.7%	16.1%	(0.26)	0.06	(0.27)	(0.13)	0.09	0.07	0.24	0.28	0.68	1.00	0.77	0.63	0.95	0.71	0.29	0.23	(0.10)	0.74	0.40
11	Global low vol equity	5.2%	13.0%	(0.24)	0.15	0.04	0.27	0.39	0.20	0.39	0.43	0.31	0.77	1.00	0.24	0.69	0.37	0.25	0.17	(0.11)	0.64	0.55
12	Canadian equity (small cap.)	6.2%	21.5%	(0.21)	0.28	(0.37)	(0.21)	0.01	0.15	0.34	0.36	0.90	0.63	0.24	1.00	0.72	0.74	0.22	0.08	(0.00)	0.57	0.10
13	Global equity (small cap.)	6.2%	17.6%	(0.30)	0.08	(0.30)	(0.16)	0.02	0.10	0.28	0.30	0.73	0.95	0.69	0.72	1.00	0.71	0.25	0.19	(0.05)	0.77	0.41
14	Emerging equity	7.3%	25.0%	(0.05)	0.28	(0.23)	(0.09)	0.11	0.21	0.37	0.41	0.78	0.71	0.37	0.74	0.71	1.00	0.38	0.20	0.08	0.55	0.26
15	Infrastructure	5.9%	13.0%	0.07	0.35	0.19	0.25	0.24	0.24	0.22	0.19	0.21	0.29	0.25	0.22	0.25	0.38	1.00	0.20	0.28	0.15	0.20
16	Core real estate (30% leverage)	5.9%	16.1%	0.31	0.01	(0.21)	(0.13)	(0.01)	(0.29)	(0.19)	(0.07)	0.16	0.23	0.17	0.08	0.19	0.20	0.20	1.00	(0.28)	0.14	(0.06)
17	Commercial mortgages	3.3%	3.5%	0.17	0.41	0.56	0.45	0.28	0.65	0.45	0.25	0.01	(0.10)	(0.11)	(0.00)	(0.05)	0.08	0.28	(0.28)	1.00	(0.18)	0.31
18	Private debt non-investment grade	6.0%	14.5%	(0.29)	0.03	(0.33)	(0.12)	0.04	0.17	0.42	0.46	0.62	0.74	0.64	0.57	0.77	0.55	0.15	0.14	(0.18)	1.00	0.47
19	Multi-asset credit	3.3%	7.9%	(0.33)	0.32	0.21	0.35	0.36	0.48	0.59	0.54	0.14	0.40	0.55	0.10	0.41	0.26	0.20	(0.06)	0.31	0.47	1.00

Source: Mercer's Canadian long-term capital market assumptions (December 31, 2021). Expected return represents expected return over the next 10 years.

-1.0 to -0.1 | -0.1 to 0.3 | 0.3 to 0.7 | 0.7 to 1.0

Custom asset classes:

3x Long Provincial Bonds = 300% Provincial long-term bonds plus -200% Treasury Bills less leverage cost of 0.5%
3x Real Return Bonds = 300% Real return bonds plus -200% Treasury Bills less leverage cost of 0.5%
Non-Marketable Bonds = 21% Provincial short-term bonds plus 27% Provincial mid-term bonds plus 52% Provincial long-term bonds
Private Debt IG (Universe) = 46% Corporate short-term bonds plus 24% Corporate mid-term bonds plus 30% Corporate long-term bonds plus 0.75% illiquidity premium
Private Debt IG (Long) = 100% Overall long-term bonds plus 0.5% illiquidity premium
All Country World Equity = 85% Global equity (large cap.) plus 15% Emerging equity

- Inflation is assumed to be 2% per annum (consistent with the Bank of Canada target) with standard deviation of 2.6%.

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