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GUY CARPENTER

FEMA

NATIONAL FLOOD INSURANCE PROGRAM

US Flood Insurance:
How Modeling and Recent Events are Transforming NFIP and the Market

David Evans – Milliman
John Kulik – Guy Carpenter
David Smith -– CoreLogic
Mitch Waldner – FIMA

CAS Ratemaking, Product, and Modeling Seminar
March 20, 2018

MARSH & McLENNAN COMPANIES

OUTLINE

1 LOSS MODELING

- Ensemble Model: NFIP View of Risk and Components
- Model Output by Sub-Peril
- Estimation of Non-Modeled Loss Distributions

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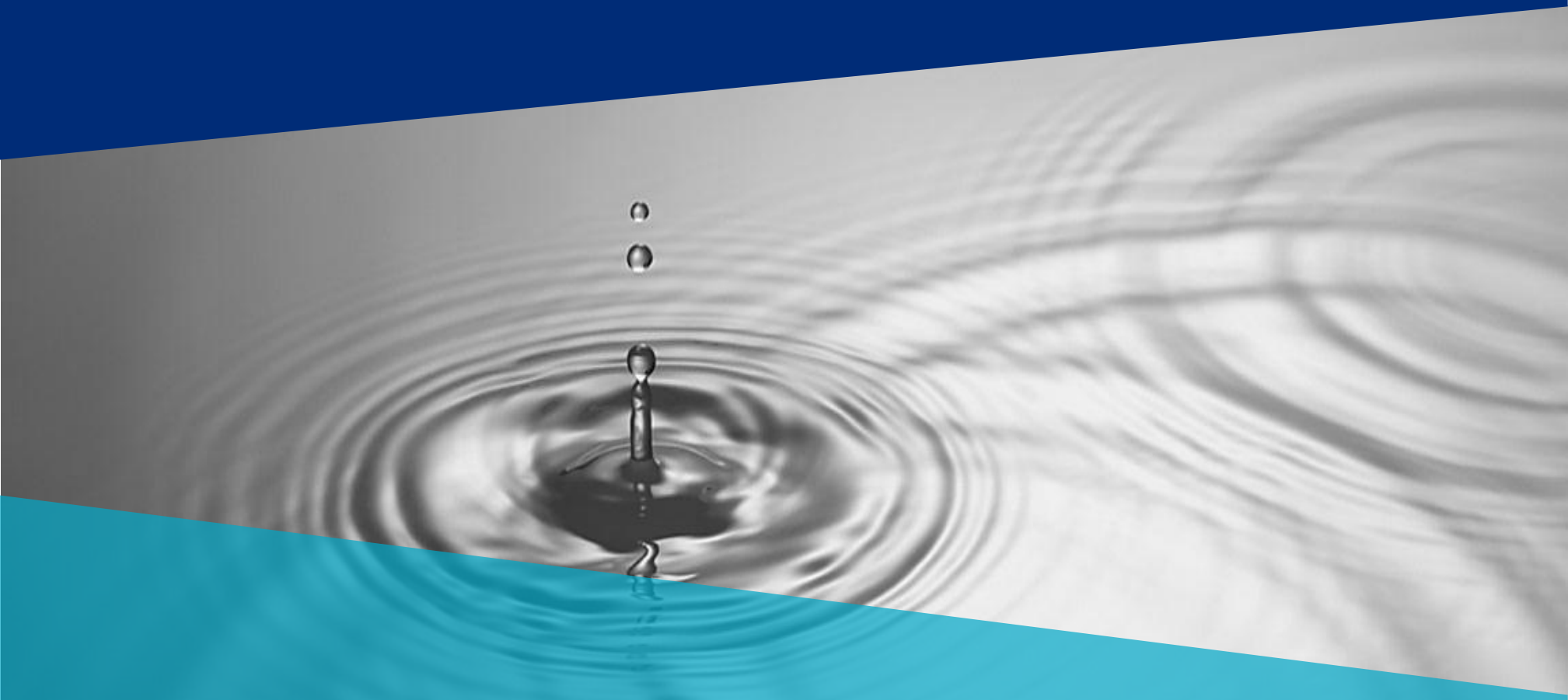
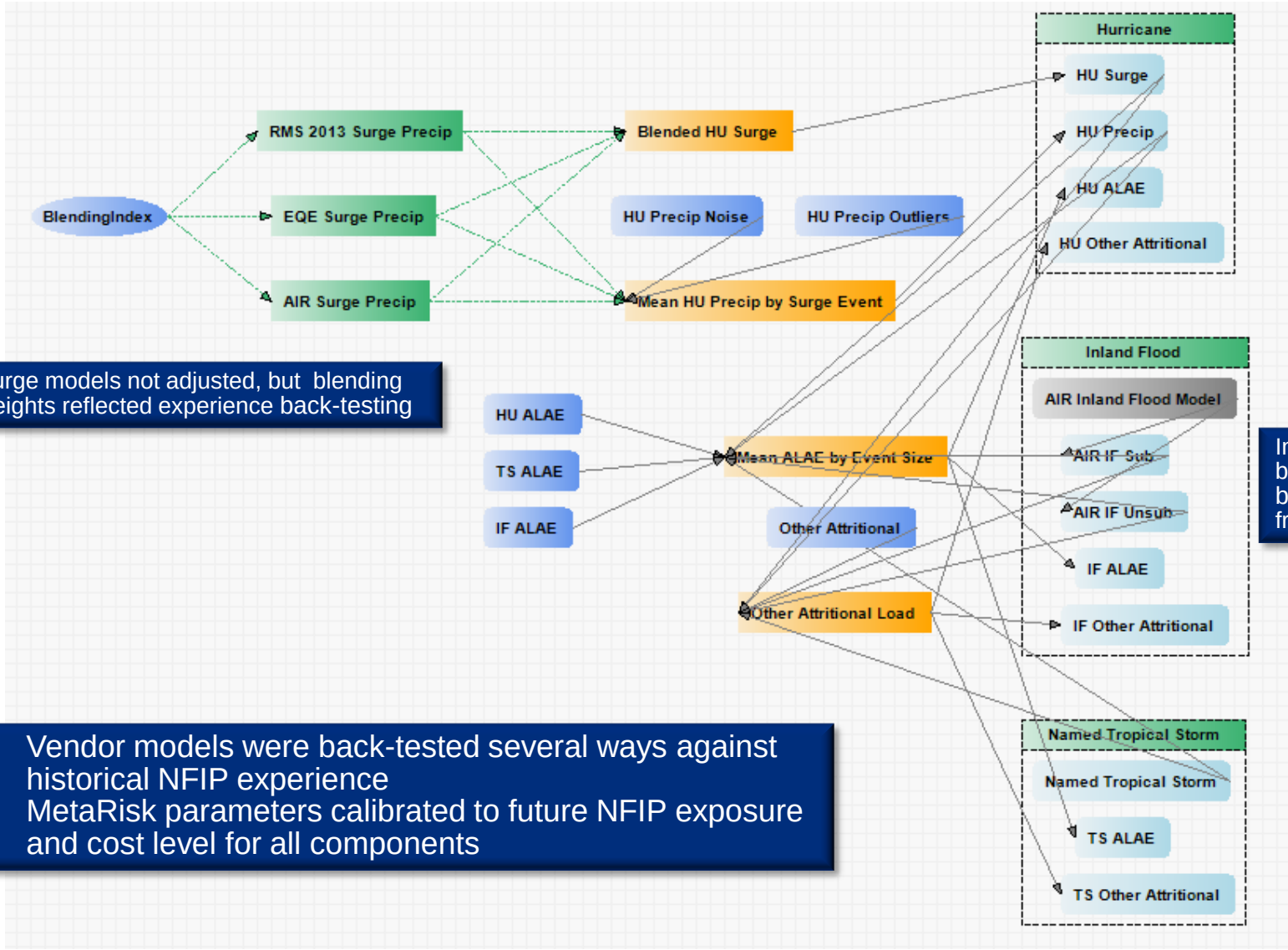
2 NFIP Financials: Stochastic Forecasts

- Revenue, Expense, and Loss Assumptions
- Projected Income Statement Means
- Projected Surplus Distributions

1 LOSS MODELING



NFIP Ensemble Loss and ALAE Model
By Sub-Peril and All Combined

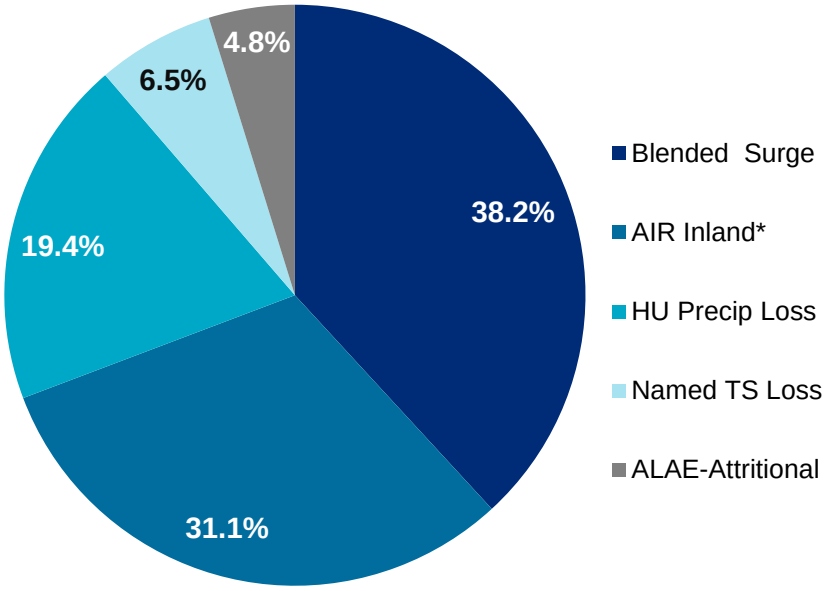


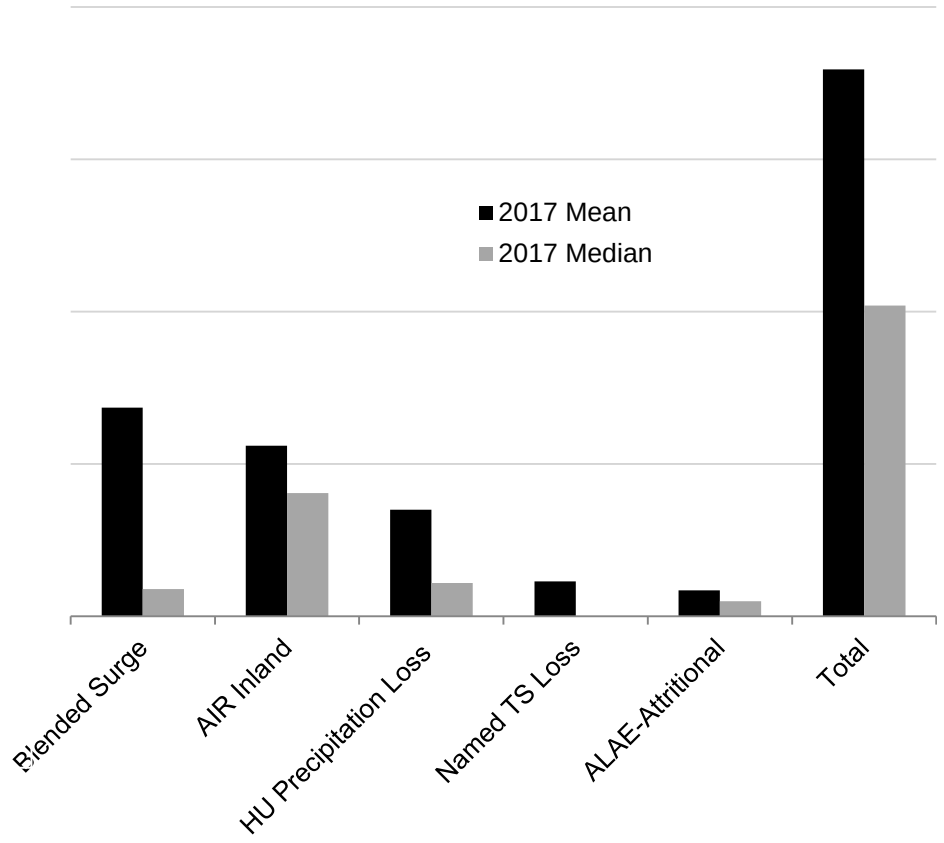
- Vendor models were back-tested several ways against historical NFIP experience
- MetaRisk parameters calibrated to future NFIP exposure and cost level for all components

NFIP Ensemble Model
Output by Sub-Peril and All Combined

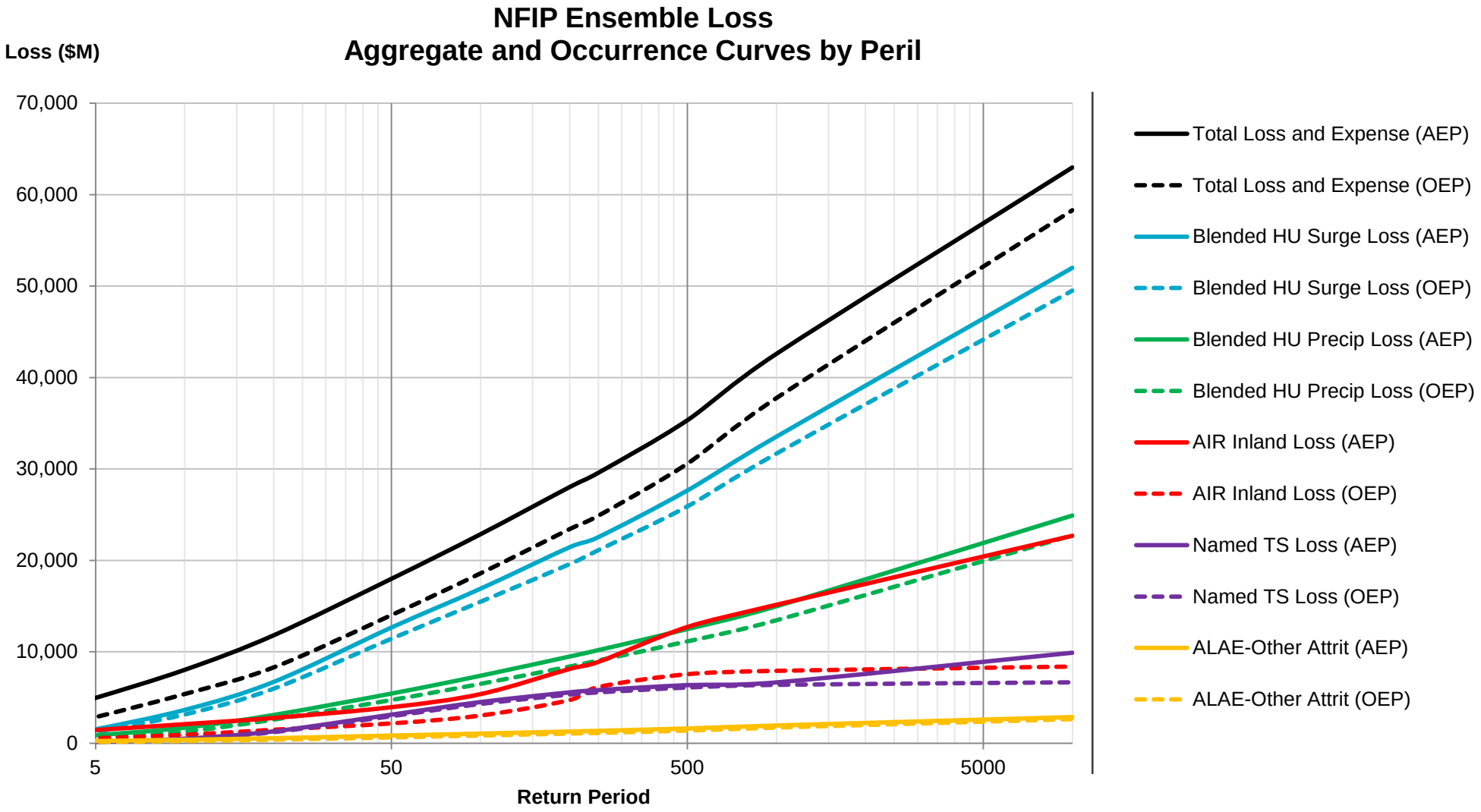
- model output reflects final weightings, adjustments, and recalibrations updated in 2016
  - *remains a "work in progress" as US flood modeling continues to develop and improve*

Contribution to NFIP Ensemble Gross AAL



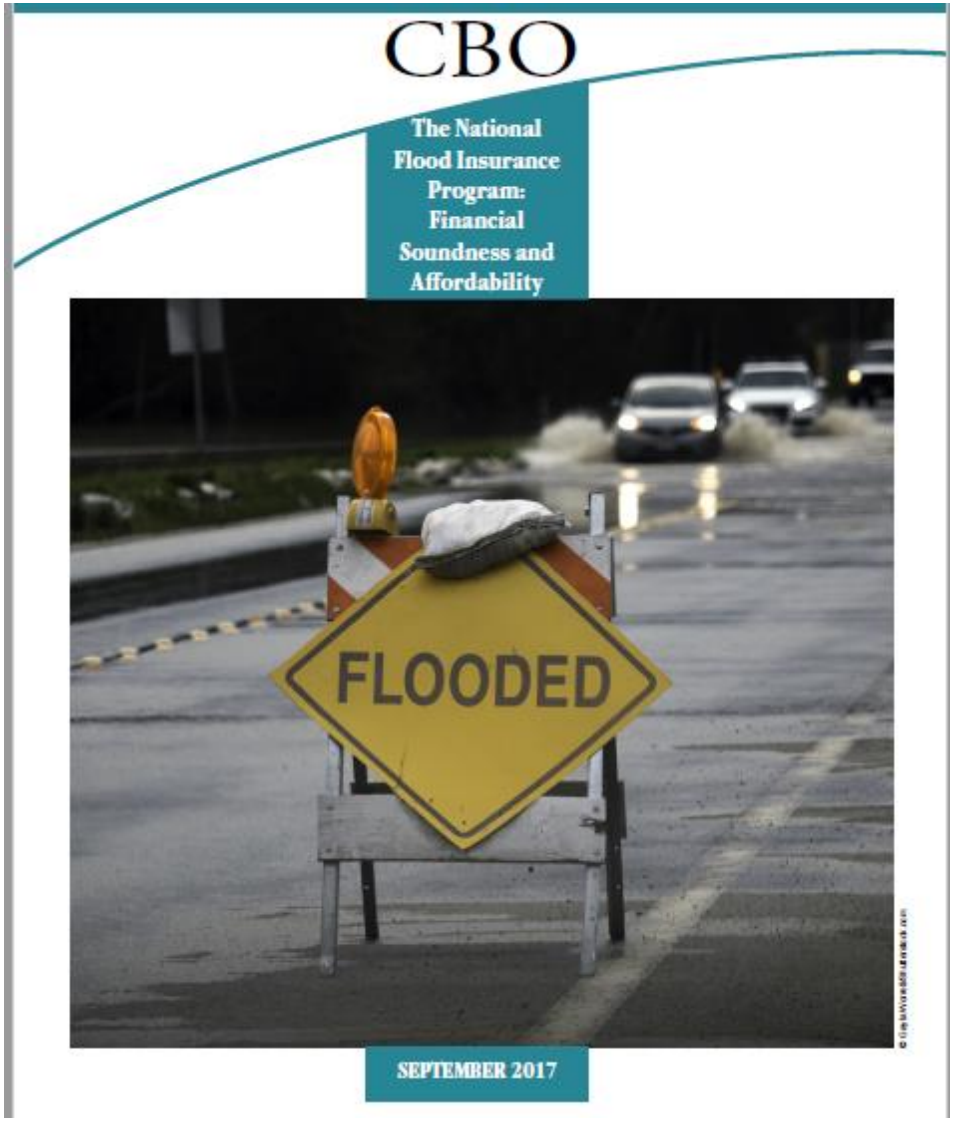


NFIP Ensemble Model
AEP and OEP Output by Sub-Peril and Combined



NFIP Ensemble Model

Latest CBO Report on NFIP Replaced Loss History with Model Output



" The estimates of gross losses from hurricane-related storm surges and inland flooding, which FEMA commissioned and CBO used, were constructed by applying policy-specific information about property value, coverage, and deductibles to estimates of flood damage produced by three commercially available models used widely in the private and public sector."

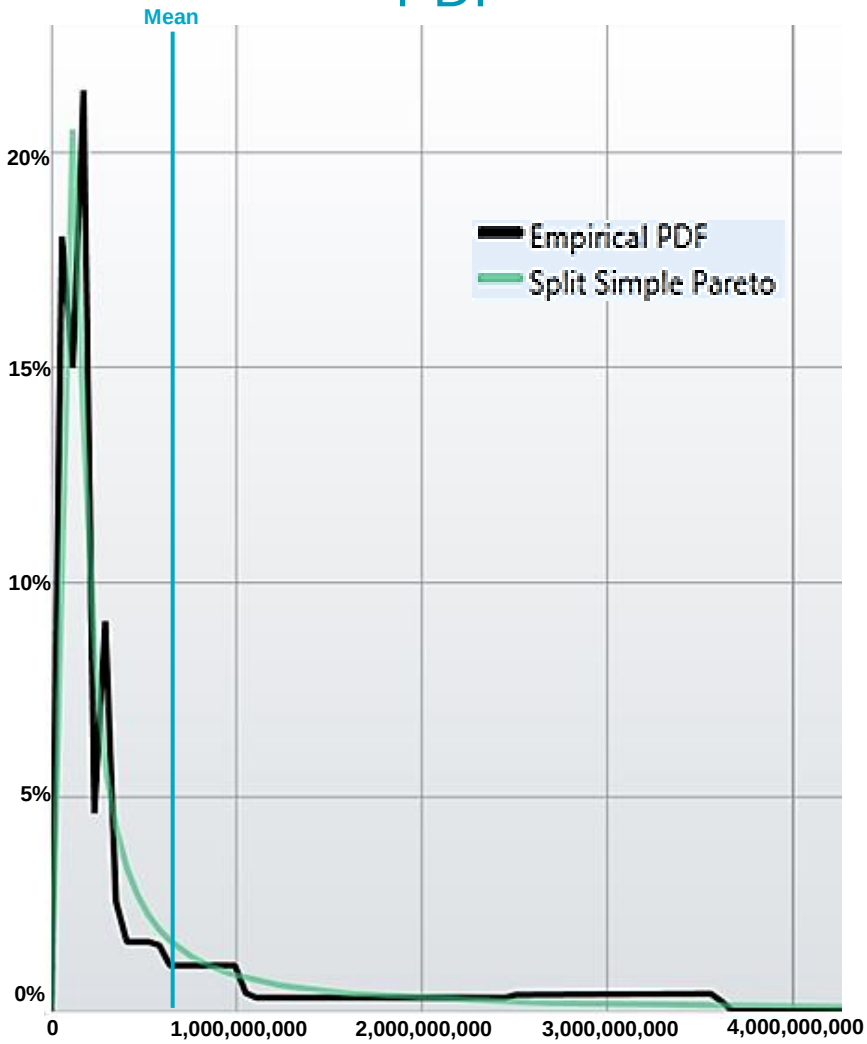
"CBO's baseline projections are based on FEMA's estimates of expected claims and not on the estimates used for this analysis, which were derived from commercial models. (CBO is exploring the applicability of those models for future baseline estimates.)"

See John Kulik and Andy Neal, "C-8: NFIP Update: Initial Steps Toward Sharing U.S. Flood Risk With the Private Sector, Presentation 1" (Casualty Actuarial Society, Seminar on Reinsurance, Boston, Mass., June 7, 2016)

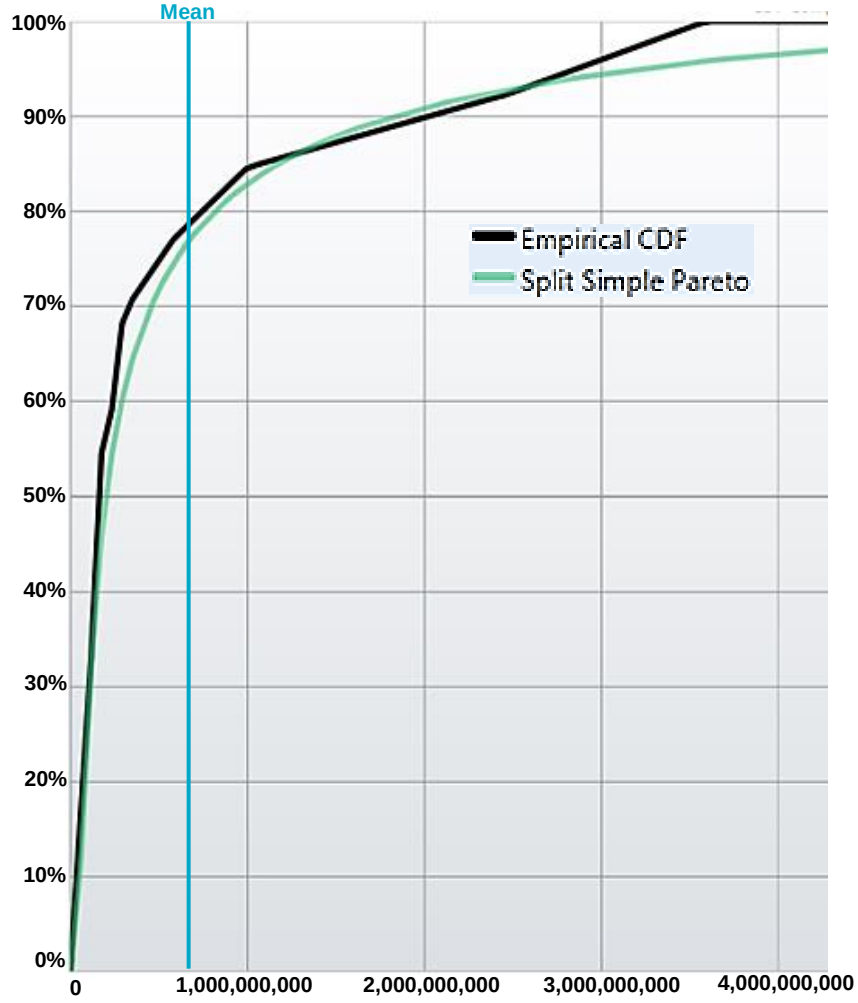
American Academy of Actuaries, Flood Insurance Work Group, *The National Flood Insurance Program: Challenges and Solutions* (April 2017)

Non-Modeled Perils – Loss Estimation
NFIP Named Tropical Storm – Fitted Severity

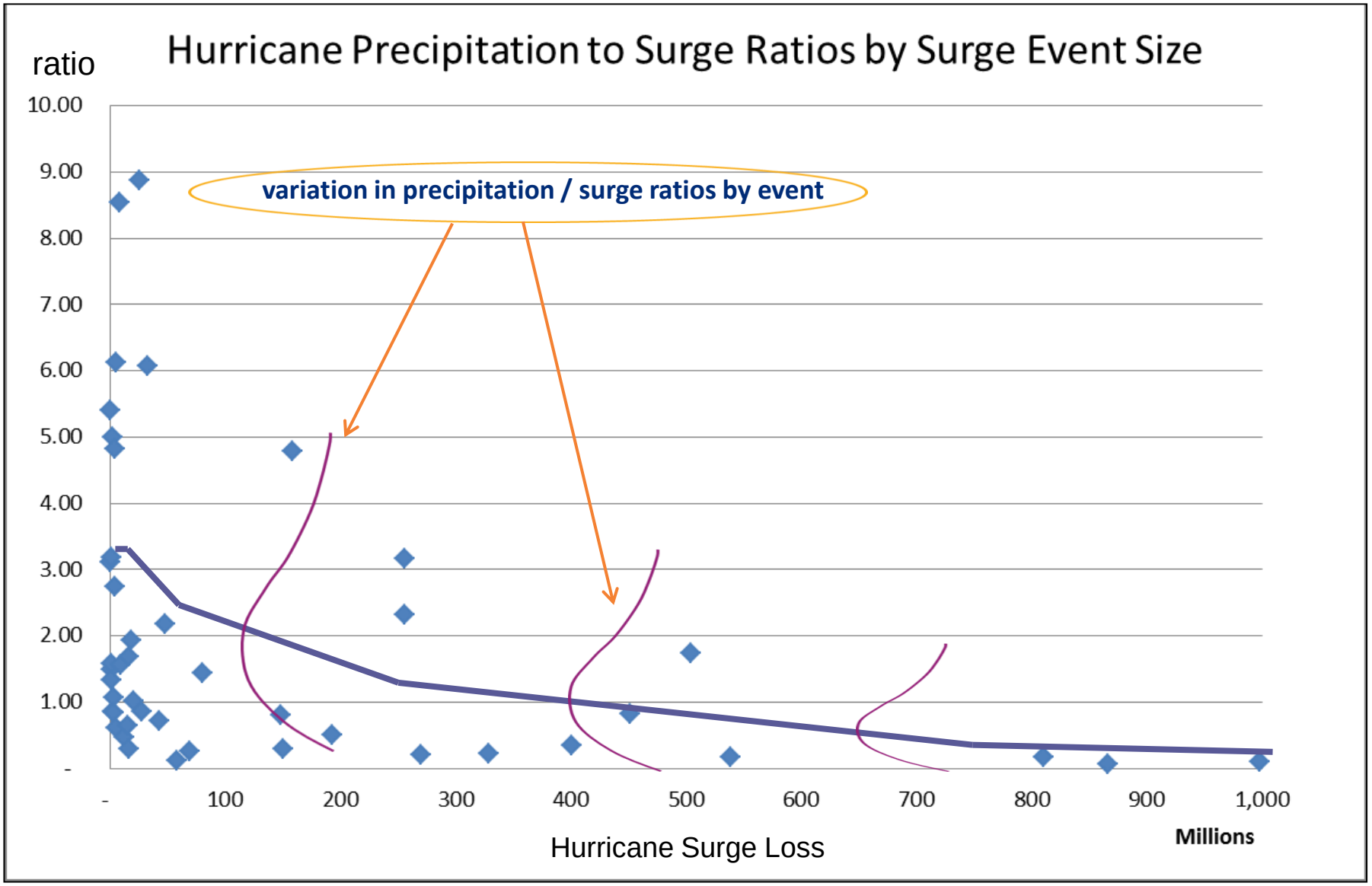
PDF



CDF



Non-Modeled Perils – Loss Estimation
NFIP Hurricane Precipitation



NFIP Hurricane Precipitation – Loss Estimation
Loading for Precipitation Outlier Hurricane Events

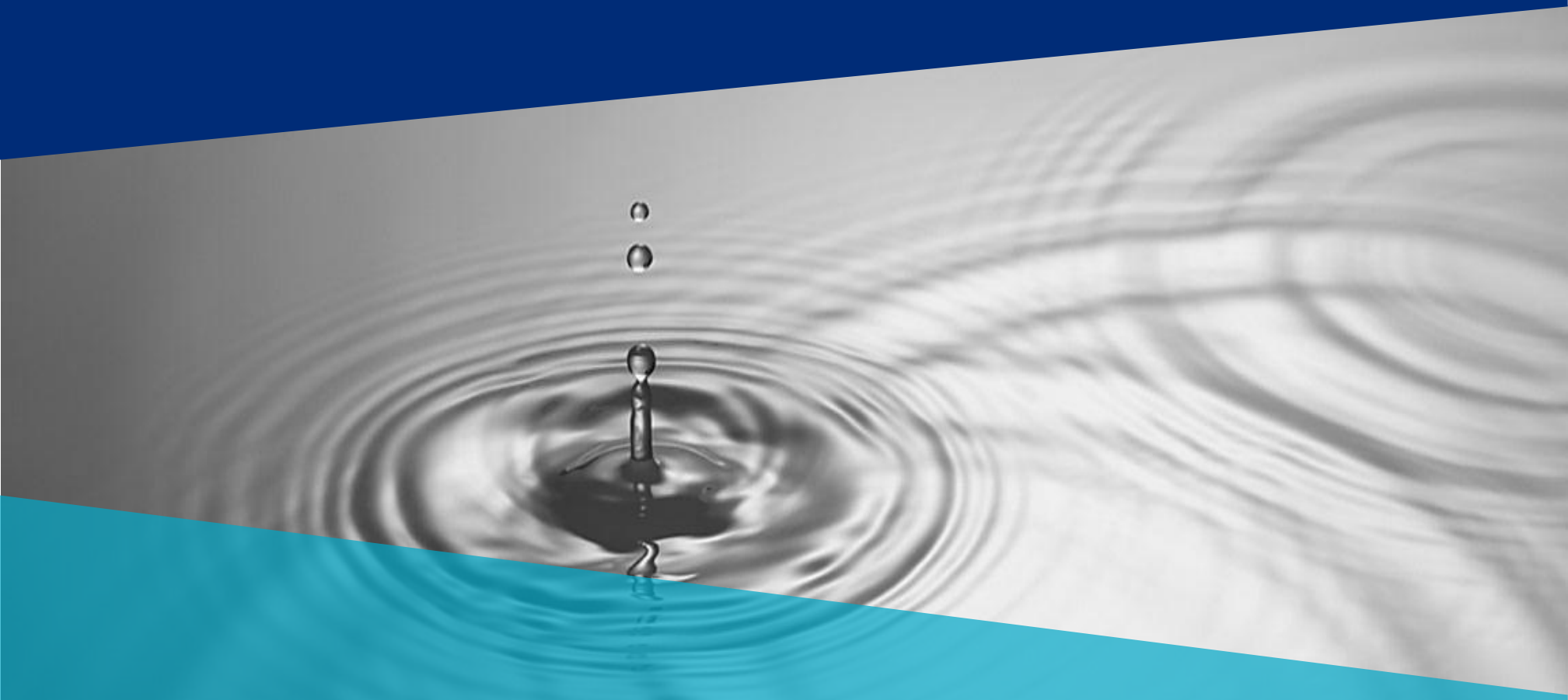
- Data in previous exhibit excluded a few outlier events with very large precipitation ratios
  - *the few outlier ratios fall significantly above the piecewise linear curve*
  - *thus the average lognormal mean is understated and requires a loading for outliers*

- To address the outliers, a multiplier to the means is generated stochastically by event
  - *Default multiplier = 1.0 is applicable the vast majority of the time*
  - *Surge loss to which the stochastic multiplier is applied is capped based on history*

- Harvey is the first hurricane precipitation outlier since the historical data that was used

- Harvey did not significantly change the indicated outlier frequency
  - *thus the original formula and parameters are still basically valid*

2 NFIP Financials: Stochastic Forecasts



NFIP Financials
Stochastic Forecasts in Flood Insurance Risk Study

REVENUE

Surcharges – flat $ charges by occupancy

Assessments – flat % charges

Unsubsidized rate increases = inflation

Subsidized rate increases > inflation
(until full risk level reached)

Newly mapped policy additions each year

FORECASTING VARIABLES and ASSUMPTIONS

EXPOSURE

Added newly mapped policies annually

- no other exposure increases assumed

Demand elasticity formula applied to:

- Premium + surcharges + assessments increases > inflation by segment
- Losses - overall average exposure reduction with a newly mapped offset

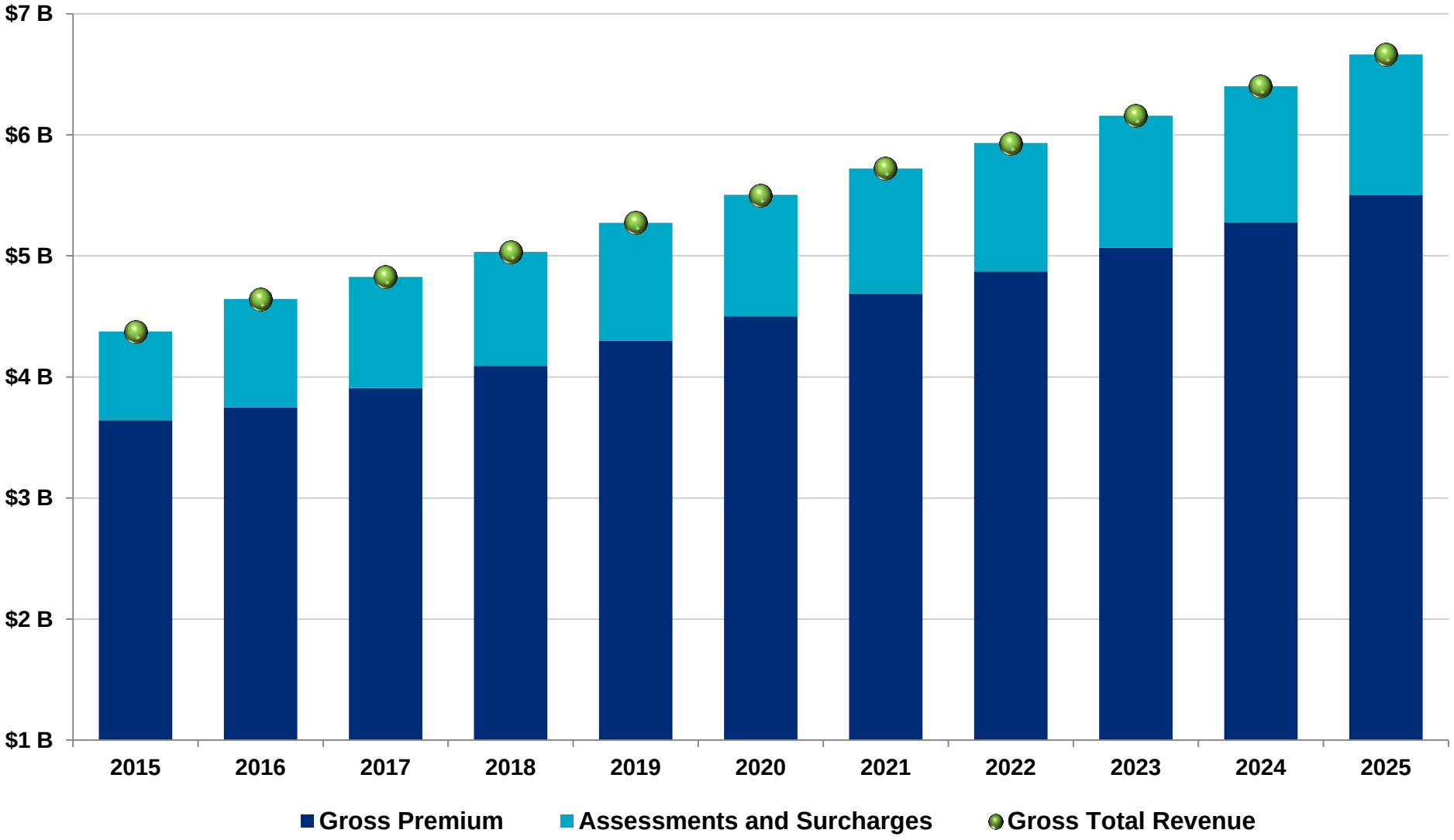
LOSSES, EXPENSES, and INTEREST RATES

Losses per exposure increased by stochastic CPI inflation annually

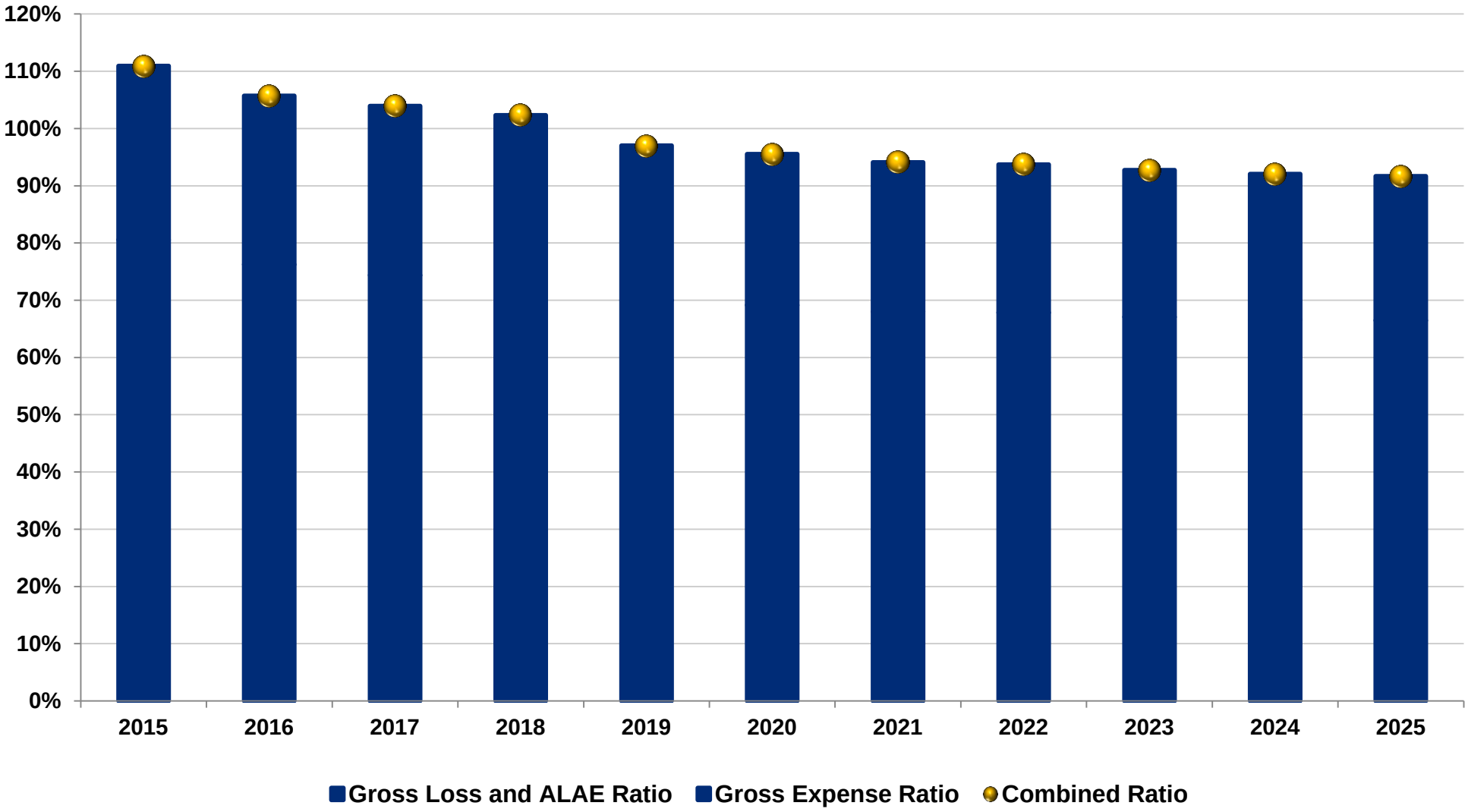
Planned expense ratio reductions to subsidized policies beginning 2019

Stochastic yield rates applied annually to investment income/debt accrual

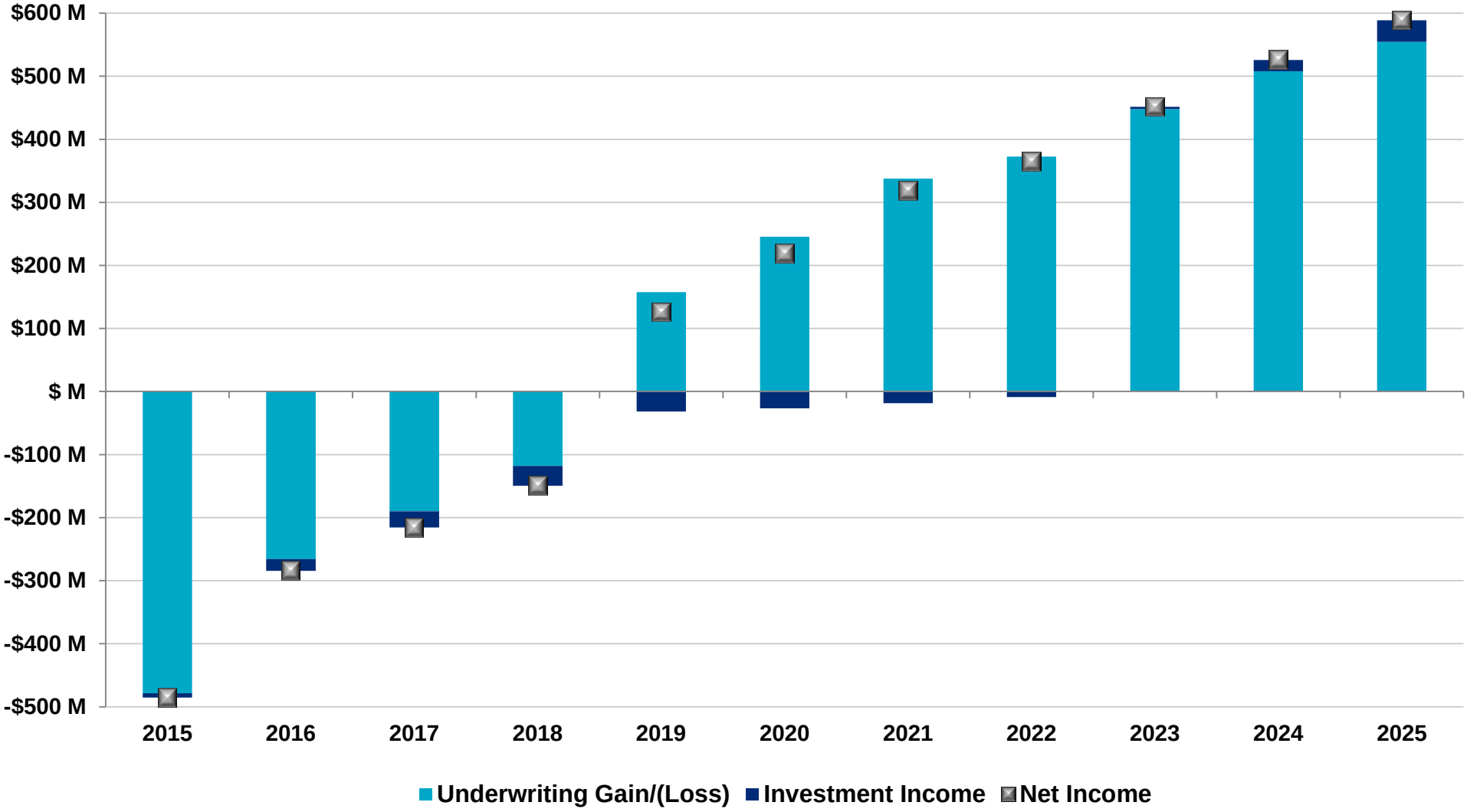
NFIP Revenue Projections
Premium, Assessments, and Surcharges



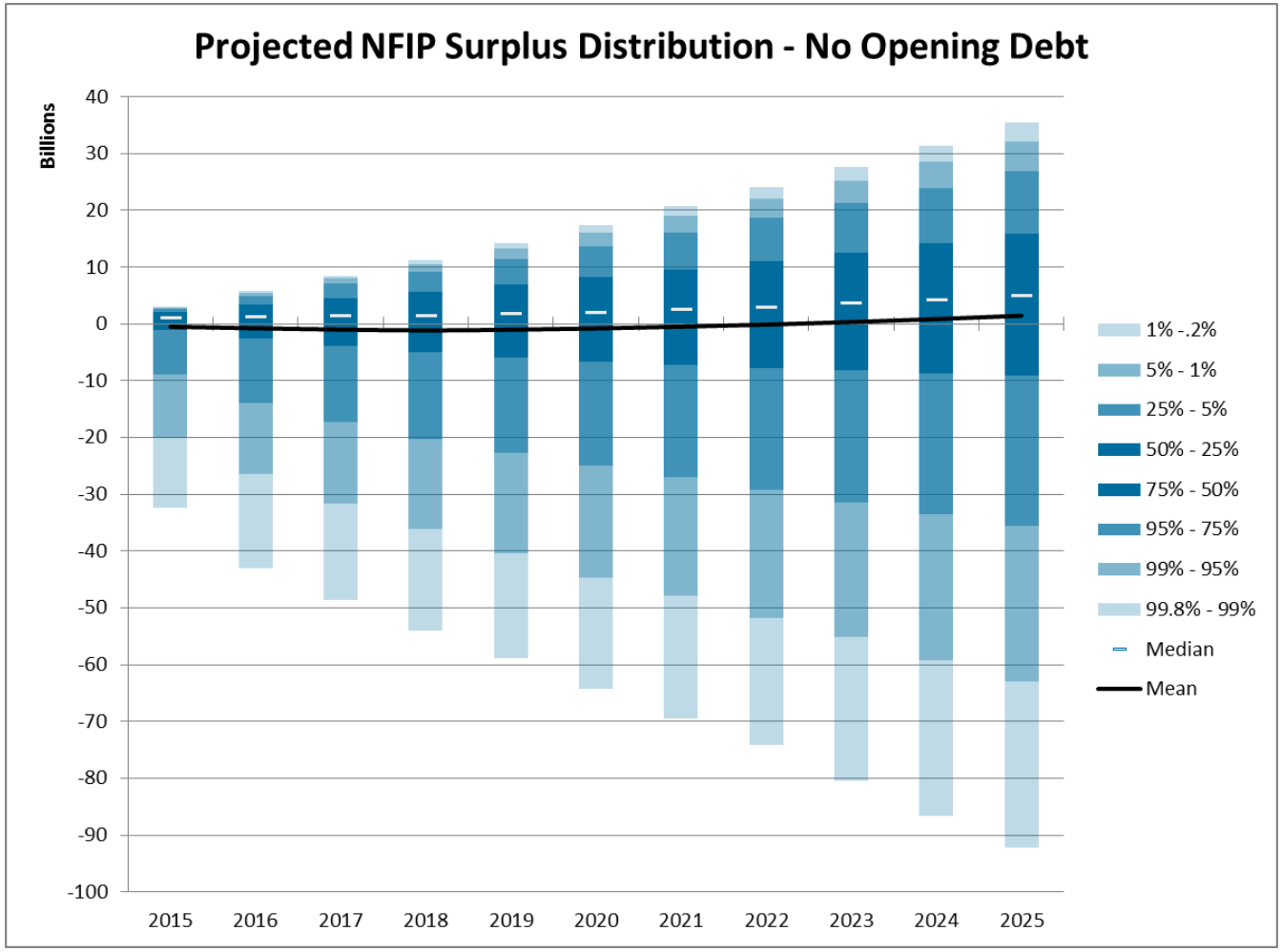
Projected NFIP Mean Underwriting Results
Combined Ratios



Projected NFIP Mean Operating Income
Underwriting Gain/(Loss), Investment Income, and Net Income



Projected NFIP Surplus Distribution – Cone of Uncertainty
Excluding Current Debt



Additional deficits still significant despite mean surplus turning positive

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This report is not intended to be a complete actuarial communication. Upon request, we can prepare one. We are available to respond to questions regarding our analysis.

There are many limitations on actuarial analyses, including uncertainty in the estimates and reliance on data. We will provide additional information regarding these limitations upon request.

As with any actuarial analysis, the results presented herein are subject to significant variability. While these estimates represent our best professional judgment, it is probable that the actual results will differ from those projected. The degree of such variability could be substantial and could be in either direction from our estimates.

The estimated cash flows may vary significantly from amounts actually collected, particularly in the event that a reinsurer is unwilling or unable to perform in accordance with the terms of the reinsurance contract.

In performing this analysis, we relied on FEMA for historical NFIP claims data, current financial data and information, and information and assumptions regarding future NFIP revenue and expense levels. We did not perform an independent review of these estimates.

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In performing this analysis, we relied on AIR for estimates regarding claim inflation and exposure trend of historical NFIP claims and exposures to current cost and exposure levels, as well as the amount of historical NFIP losses for subperils for which their current software models do not provide estimates. We did not perform an independent review of these estimates.

In performing this analysis, we relied on Moody's for estimates regarding economic scenarios of future interest rates and inflation rates. We did not perform an independent review of these estimates.

The results in this report are generated with software models provided by Risk Management Solutions, Inc.
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