Affordability of National Flood Insurance Program Premiums: Report 2

DETAILS

156 pages | 6 x 9 | PAPERBACK
ISBN 978-0-309-38077-5 | DOI: 10.17226/21848

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AFFORDABILITY OF NATIONAL FLOOD INSURANCE PROGRAM PREMIUMS

REPORT 2

Committee on Affordability of
National Flood Insurance Program Premiums

Water Science and Technology Board
Division on Earth and Life Studies

Board on Mathematical Sciences and Their Applications
Division on Engineering and Physical Sciences

Committee on National Statistics
Division on Behavioral and Social Sciences and Education

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Washington, DC
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001

This activity was supported by the Federal Emergency Management Agency Contract Number HSHQDC-11-D-0009/HSFE60-13-J-0025. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project.

International Standard Book Number-13: 978-0-309-38077-5
International Standard Book Number-10: 0-309-38077-4

Additional copies of this report are available for sale from the National Academies Press, 500 Fifth Street NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

Cover: Image courtesy of the U.S. Coast Guard.

Printed in the United States of America.

Suggested citation: National Academies of Sciences, Engineering, and Medicine. 2016. *Affordability of National Flood Insurance Program Premiums—Report 2*. Washington, DC: The National Academies Press.

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Acknowledgments

The report was reviewed in draft form by individuals chosen for their breadth of perspectives and technical expertise in accordance with the procedures approved by the National Academies' Report Review Committee. The purpose of this independent review was to provide candid and critical comments to assist the institution in ensuring that its published report is scientifically credible and that it meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report: Kenneth J. Arrow, National Academy of Sciences/National Academy of Medicine, Stanford University; Bruce Bender, Bender Consulting Services, Inc., Phoenix, AZ; Chad Berginnis, The Association of State Floodplain Managers, Madison, WI; Lawrence D. Brown, University of Pennsylvania, Philadelphia; Lloyd Dixon, RAND Corporation, Santa Monica, CA; Gerald Galloway, National Academy of Engineering, University of Maryland, College Park; Earthea Nance, Texas Southern University, Houston, TX; and Doug Plasencia, Michael Baker Jr. Inc., Phoenix, AZ.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Michael Goodchild, University of California, Santa Barbara, and David Moreau, University of North Carolina, Chapel Hill. Appointed by the National Research Council (NRC), they were responsible for making certain that an independent

examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the NRC.

Preface

The National Flood Insurance Program (NFIP) was created by Congress in 1968 and over the years an uncounted number of studies and reports have reviewed the program's structure and operations, often making recommendations for reform. Many, but not all, of these reports were made at the request of Congress. The reports of this committee were prepared in response to a congressional request in the Biggert-Waters Flood Insurance Reform Act of 2012 (BW 2012).

BW 2012, Section 100236, mandated that the Federal Emergency Management Agency (FEMA) conduct a study in cooperation with the National Academy of Sciences (NAS) that would "compare the costs of a program of risk-based rates and means-tested assistance to the current system of subsidized flood insurance rates and federally funded disaster relief for people without coverage." This came to be known as the "affordability study" as a shorthand reference.

In response, the Water Science and Technology Board in the Division on Earth and Life Studies at NAS, in collaboration with the Board on Mathematical Sciences and their Applications, and the Committee on National Statistics, convened the committee on *Affordability of National Flood Insurance Program Premiums*. The committee members for both reports included persons who collectively brought expertise in insurance, economics, floodplain management, national flood and disaster science and policy, mapping and spatial statistics, and risk perception and communication to the work of the committee.

To fulfill the mandate of BW 2012, FEMA and NAS agreed to a plan of work to produce two reports. The first report, titled "Affordability of

National Flood Insurance Program Premiums—Report 1," described policy options and decisions to be made for FEMA's consideration as it formulates affordability policy alternatives for consideration by Congress. The first report was publicly released for prepublication on March 26, 2015. A second report focused on how FEMA might develop analytical capacity and databases needed to evaluate affordability policy alternatives. The committee was not tasked to complete such a study.

The committee process for preparing the two reports began in late 2013. The committee met five times during 2014 and 2015—January 2014, March 2014, July 2014, November 2014, and May 2015. The first four meetings were held in Washington, D.C., and the last meeting was held in Irvine, California. The first three meetings included guest presentations and we thank the many individuals who presented to the committee and provided reference materials. We list these in Appendix D of Report 1; the latter two meetings were mostly closed committee meetings.

In addition to those who presented, the committee recognizes three specific contributions. We thank Susan Phelps, as well as her employer AECOM, for her helpful contributions in working with the NFIP policy database and in preparing numerous maps and tables for consideration by the committee, many of which were not included in this final report.

The content of the second report drew heavily from the results of the proof-of-concept report that will be published as the North Carolina Floodplain Mapping Program. John Dorman, Program Director, and his staff provided a draft of the report to the committee and were responsive to requests for further explanations and clarifications of the report content.

We especially thank Andy Neal from FEMA for helping the committee understand the details of the NFIP program and for his timely, comprehensive, and enlightening replies to questions from the committee.

Through meetings, phone calls, and email exchanges each committee member has enthusiastically shared their expertise and knowledge and as a result has made valuable contributions to the report. I owe them all my gratitude. I would especially like to thank Dr. Allen Schirm from Mathematica Policy Research. Allen is an expert in assistance program design and microsimulation analysis. These topics became central to our committee's work and we relied upon Allen's advice and knowledge to a much greater extent than we, and maybe he, had expected. Allen's commitment to the project and spirit of collegiality were crucial to the successful completion of our reports.

Finally, I want to thank particular NAS staff. Dr. Connie Citro prepared essential text that appears in the second report. Dr. Jeffrey Jacobs served as study director for the first report and Dr. Ed Dunne served as study director

for the second. Their attention to keeping the committee focused on its task and moving our reports to completion is truly appreciated.

Leonard Shabman, *Chair*
Committee on the Affordability of National
Flood Insurance Program Premiums

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Summary

When Congress authorized the National Flood Insurance Program (NFIP) in 1968, it intended for the program to encourage community initiatives in flood risk management, charge insurance premiums for new construction that was based on the flood risk at the property, and encourage the purchase of flood insurance by owners of flood-prone properties (that is, seek a high takeup rate), in part by offering affordable premiums. The NFIP has been reauthorized many times since 1968, most recently with the Biggert-Waters Flood Insurance Reform Act of 2012 (BW 2012). In this most recent reauthorization, Congress placed a particular emphasis on setting flood insurance premiums following actuarial pricing principles, which was motivated by a desire to ensure that future revenues were adequate to pay claims and administrative expenses (NRC, 2015a).

BW 2012 would have increased premiums for policyholders who had previously been paying less than NFIP risk-based premiums and possibly would increase premiums for all policyholders. Subsequently, congressional concern for the effect of that legislation on the affordability of flood insurance led to the Homeowner Flood Insurance Affordability Act (HFIAA 2014), modifying some provisions of BW 2012. HFIAA 2014 (Section 9) further emphasized that the Federal Emergency Management Agency (FEMA) report to Congress with a plan for an "affordability framework" following its submission of the affordability study that was originally required by Section 100236 of BW 2012.

The legislative language that called for an affordability study directed FEMA to seek advice from the National Academy of Sciences (NAS). In

response, NAS convened the Committee on the Affordability of National Flood Insurance Program Premiums that was directed by its task statement to prepare two reports. The first report (Report 1) was released in March 2015. It included chapters on the history of the NFIP pricing practices, the demand for flood insurance, considerations for design of an assistance program for persons who might be cost burdened by rising premiums, and policy options that could make premiums less expensive for all policyholders (NRC, 2015a). The summary of Report 1 is included as Appendix A.

This report (Report 2) proposes an analytical approach FEMA might use to evaluate affordability policy options such as those described in Report 1. In preparing Report 2, the committee's work was informed by lessons learned from a proof-of-concept pilot study completed in North Carolina specifically for this committee's work. The state of North Carolina has extensive data on floodplain properties and it has extensive experience in conducting analyses, using models, of flood risk management options. That proof-of-concept report[1] undertaken by the North Carolina Floodplain Mapping Program (NCFMP) is an independently written, companion document to the committee's report (see Box 1-1, Chapter 1, for the complete statement of task for Report 2).

Chapter 2 of this report describes model development for evaluating affordability policy options and their application to the NFIP. The analytical requirements to evaluate options led the committee to specifically consider microsimulation techniques to support a structured approach to assess NFIP policy options. How such analyses may be conducted is illustrated with examples of model output from the North Carolina proof-of-concept report. Chapter 3 discusses the data available to the NFIP and from other sources for conducting such analyses. Further, it describes ways to fill data gaps.

FEMA is directed to propose an affordability framework to Congress 18 months after completing the affordability study.[2] The affordability framework was to include actions that advanced the original goals for the NFIP, which were to ensure reasonable insurance premiums for all, base all premiums on risk, secure widespread participation, and earn premium and fee income that covers claims and expenses. Ideally, FEMA would formulate affordability policy alternatives for consideration, conduct an evaluation of the alternatives, and propose a preferred affordability strategy. Policy analysis capacity and necessary data, however, currently are not available to complete a comprehensive analysis of affordability policy options. None-

[1] The NCFMP (2015) report is publicly available at http://dels.nas.edu/resources/static-assets/wstb/miscellaneous/wstb-cp.pdf.

[2] Section 100236 of BW 2012 states "methods to aid individuals to afford risk-based premiums under the NFIP through targeted assistance rather than generally subsidized rates, including means-tested vouchers."

theless, FEMA can complete some limited analyses in the near term as the agency builds its analytical modeling capacity and database through time. Chapter 4 suggests such initial analyses.

In the process of preparing its second report, the committee had the opportunity to reflect on Report 1 findings and, as a result, develop additional findings for FEMA to consider as it prepares its affordability framework for Congress. Chapter 4 includes these additional findings. This report summary includes select findings from Chapters 2, 3, and 4. These are findings the committee believed were of the highest immediate priority. A complete list of all report findings are presented at the end of each chapter. All the committee findings are shown in bold text and reflect chapter number and sequence of findings in the respective chapter.

BUILDING MODELING CAPABILITY

A structured analytical process will provide answers to policy questions. For example, if BW 2012 reforms are in effect, will premiums exceed the ability of owners to pay for insurance for flood-prone properties? And what are the policy alternatives that can make premiums affordable for those who have limited ability to pay?

The need to answer such questions directs attention to development of models and data for estimating the effects of BW 2012 (the baseline condition) and then estimating how affordability policy options alter those effects of BW 2012. Microsimulation techniques often are well suited to making these estimates. Microsimulation models have two essential elements: (1) a microdatabase and (2) a computer program. To answer the policy questions implied in Section 100236 of BW 2012 the database would include information about each NFIP policyholder (or a sample of such policyholders), about their property characteristics, and about their policy. Ideally, the database also would include information about property owners and their properties located in flood-prone areas that do not purchase an NFIP policy, but might in the future. To estimate future flood damage to specific properties the database would require information that characterizes the likelihood of floods of different magnitudes and property-specific flood loss estimates based on the first-floor elevation. With these data available, the model's computer program would simulate NFIP premium-setting practices and estimate premiums paid under both the "baseline condition" policy of BW 2012 and for any alternative affordability policy options that reduce flood insurance premiums (Report 1, Chapter 7).

If there are options that provide financial assistance to property owners who would be unable to pay the premium (Report 1, Chapter 6) then the program would have to simulate the assistance program's rules that determine whether the property owner is eligible for assistance and estimate how

much assistance the property owner might receive. Other effects of interest might include, but would not be limited to, expected future insurance claims (especially if the assistance includes mitigation) and whether the policyholder would no longer purchase a policy at a higher premium (Report 1, Chapter 4). Making calculations for individual property owners and aggregating the results identifies effects on NFIP net revenues, on federal budget expenditures, and on the flood insurance takeup rate across all property owners and subgroups of interest (for example, low-income households).

Microsimulation is an attractive modeling approach because it focuses first on the individual policyholder and property owner. It can also aggregate results across policyholders to produce national estimates and estimates for categories of interest (i.e., income groups or geographic areas). This focus on the policyholder could address the concerns of those who will find premiums unaffordable, who might receive aid, and who might choose to purchase flood insurance. Microsimulation models, however, are necessarily complex to reflect the complexities of government programs and individual circumstances. As a result, their construction requires substantial time and resources. There are professionally recognized practices FEMA can rely upon if FEMA develops a microsimulation model. Among these accepted practices are building self-contained modules that can be readily added to or removed from a more comprehensive model. This in effect builds capacity incrementally as new and better data become available. The pace at which the modeling capacity grows will be determined by the resources available, access to appropriate expertise, and the support of agency leadership.

Finding 2.1: FEMA's capability to evaluate affordability policy options is very limited but can be substantially advanced by embracing a microsimulation modeling approach and building the model incrementally through time. This would begin with conceptual microsimulation model design and the writing of computational algorithms for the self-contained modules as necessary data are identified and data gaps filled.

INFORMATION FOR MICROSIMULATION MODEL IMPLEMENTATION

The microsimulation approach requires the construction of one or more microlevel databases. Data records for each property could include data on variables that characterize property features, socioeconomic characteristics of the property owner and occupant (if different from the owner), and the NFIP policy (if there is a policy in force on that property). The committee reviewed the policy data records in the October 2013 NFIP policy database. The database does include some of the necessary data, but there are incomplete records. A particularly important gap in the data

was the absence of structure first-floor elevation data that are necessary for estimating the damage to the structure from floods of different magnitudes. While some of those data are now being collected for properties inside the special flood hazard area (SFHA), such data are not available and are not being collected for properties outside the SFHA. Also, even if all of the data in the NFIP database were complete and accurate, the database cannot be used to simulate affordability assistance programs that are means tested because the database does not contain income, wealth, or housing cost data. Furthermore, the NFIP database does not contain information for nonpolicyholders located in flood-prone areas and cannot be used to analyze whether an alternative policy option that would reduce premiums or provide assistance might promote takeup among such households.

Some microsimulation model analyses will be for flood claims and perhaps needed to simulate the effects on premiums from new alternative policy options. Making these estimates will depend on information about the likelihood that different floods reach different stages in different areas of the floodplain and the claims resulting from these floods. Only some flood insurance rate maps (FIRMs) include such needed information. Other data sources might be used to replace or supplement the data provided through the FIRMs such as the risk and damage assessment computer software tools from the U.S. Army Corps of Engineers and the tools found in FEMAs Hazus model.

Finally, response functions that can be used to simulate the behavioral response of property owners to changes in policy will be needed to improve the accuracy of estimates. Two examples of response functions include how takeup rates will vary with premiums charged and how premium levels and offers of assistance might affect the demand for flood mitigation. The professional literature provides only a limited basis for developing such response functions. Sensitivity analyses could be used to assess the uncertainty in modeling behavioral responses.

The committee reviewed options for filling data gaps from existing sources for use in microsimulation modeling. These included securing data on socioeconomic characteristics of property owners from the decennial census of population and the continuing American Community Survey (ACS) or administrative records from the Internal Revenue Service (IRS) or the Social Security Administration (SSA). Decennial census and ACS data are of limited usefulness, and although administrative records from IRS or SSA could provide useful data, it might be difficult (due to time constraints) to obtain access to and begin using such data in the near term. Property characteristics might be obtained from commercial enterprises that now collect data at the individual property level and perform their own analyses of home prices from tax assessor records. Some of these sources hold promise for securing necessary data, but none offered readily accessible data.

Certain data gaps could also be filled with data from a new sample survey conducted on behalf of FEMA specifically for the NFIP. Depending on the interviewing mode (personal interviews could be desirable for a FEMA survey because of the ability to capture information by observation of the property) and the extent of follow-up needed to bring response rates up to acceptable levels, however, a survey could be very costly. The necessary number of completed survey cases will be a function of the extent of disaggregation of microsimulation model results that is desired (greater disaggregation requires a larger sample for precision) and the budget the agency can allocate. It is unlikely that new survey data could be obtained in the near term.

Finding 3.3. Information available from the NFIP policy database and from FIRMs are missing data critical to a comprehensive analysis of affordability policy options. Numerous other sources of information, including new survey data collection, could be used to conduct microsimulation policy option analyses. Although the data for a national affordability study initially will be limited, numerous opportunities for database improvement for answering NFIP policy questions can be secured as budget resources permit.

NEAR-TERM ANALYSIS

FEMA's current modeling capability and the data available cannot support building a microsimulation model for a comprehensive affordability analysis. Nonetheless, there are analyses FEMA can undertake in the near term. For example, some assistance program design questions require nonquantitative analysis. For example, who might administer an assistance program? Answers to such a question will affect the formulation of alternative policy options. Also, based on a conceptual-level argument and an understanding of each possible alternative, some might be initially removed from consideration (maybe to be reintroduced at a later date). For example, the discussion in Report 1 on disaster savings accounts, tax credits and deductions, and capping the NFIP responsibility to pay claims in high-loss years might be put aside if the alternative policy option is expected to have little applicability to low-income property owners.

After this kind of initial screening, some policy alternatives will remain candidates for inclusion in an affordability framework and could be subject to quantitative analysis. With this need in mind, FEMA could begin the conceptual development of modules that can answer some of the important policy questions. As one example, a question that can be answered now is how much premiums would increase if policyholders who were paying pre-FIRM subsidized (PFS) rates had to pay NFIP risk-based rates. This is the

baseline estimation needed to begin an analysis of affordability policy options. Answering this question requires a module to replicate the premium-setting practices of the NFIP to include rating tables, coverage selection, zone, and property characteristics including first-floor elevation. FEMA could use the data now being collected on first-floor elevations to impute first-floor elevations on PFS structures for which elevation data are not yet available. FEMA might be provided with the necessary resources and study schedule flexibility that will allow for a data development process to fill in critical, but missing, socioeconomic data on policyholders and property owners in specific geographic areas in North Carolina. This would allow FEMA to build on the proof-of-concept study to provide an evaluation of a number of affordability policy options, recognizing that the North Carolina results would be state specific.

Finding 4.1. Some decision-relevant analyses can be completed with currently available analytical tools and data, or with limited investments in methods and database development. In the process of doing such analyses, FEMA also will make progress toward building analytical capacity to conduct more comprehensive policy analyses in the future.

COMMITTEE REFLECTIONS AFTER REPORT 1

The committee was responsible for preparing two reports. The task for the first report was to describe concepts of affordability, assistance program design decisions, and policy options that may reduce the cost of premiums for those who were cost burdened by premium increases called for by BW 2012. To address its task, Report 1 was organized by chapters on pricing (Chapters 2 and 3), insurance demand (Chapter 4), location of affordability issues (Chapter 5), defining cost burden as ability to pay and assistance program design decisions (Chapter 6), and affordability policy options (Chapter 7). As a result of its work preparing Report 2, the committee developed additional findings regarding NFIP pricing after BW 2012, defining cost burden and ability to pay, and linking mitigation and premium assistance. In the process of preparing Report 2, the committee had the opportunity to reflect on its first report. The select new findings that the committee wishes to highlight are discussed below and other new findings can be found in Chapter 4.

NFIP PREMIUMS AFTER BW 2012 AND HFIAA 2014

Chapters 2 and 3 in Report 1 discussed NFIP rates and rate setting and the changes called for by BW 2012 and HFIAA 2014. With specific reference to rates and BW 2012, Congress instructed the NFIP to move toward

flood insurance premiums that better reflected the full risks of flooding at a given location, following actuarial pricing principles. In Report 2, the committee developed two additional findings regarding the effectiveness of BW 2012 in promoting actuarial-based pricing for the NFIP.

Grandfathered polices are allowed to maintain a lower flood insurance premium if a new FIRM moves the property into a higher flood-risk zone or identifies a new base flood elevation (BFE). BW 2012 eliminated grandfathering, but it was reinstated in HFIAA 2014. Report 1 found that the NFIP sought to compensate for the forgone revenues from grandfathering through a cross subsidy from other policyholders. This cross-subsidy violates the actuarial principle that each policyholder pays rates commensurate with its flood risk. Specifically, for policies that are grandfathered, premiums will be too low, and for those who pay the cross subsidy, premiums will be too high. In the future, and in the context of climate change, land development, and improved flood mapping, some properties will be mapped into SFHAs when they are not currently located or will have higher estimated BFEs. The owners of those properties will have the opportunity to pay grandfathered rates under HFIAA 2014, and the NFIP practice of increasing rates for all policyholders to account for revenue loss from grandfathering may continue.

Finding 4.2. HFIAA 2014's reinstatement of grandfathering, which will perpetuate cross-subsidies in the NFIP, will result in the program increasingly violating actuarial pricing principles if flood risks increase in the future.

The NFIP divides the floodplain into the SFHA and the area beyond the SFHA. Within the SFHA, PFS rates, even after HFIAA 2014, will be phased out and replaced with NFIP risk-based rates. This means that about 20 percent of all policyholders will pay a rate that is more compatible with actuarial pricing principles. As noted, grandfathering was to be eliminated, but HFIAA 2014 reinstated the practice with the result that rates for those properties will be NFIP risk based, but perhaps rated in the wrong flood zone. The number of grandfathered polices is not known. Also, policyholders who live in communities that take actions to reduce flood risk can earn points in the Community Rating System (CRS). Policyholders participating in the CRS receive discounts on the NFIP risk-based premium; some community actions that earn CRS points may reduce expected losses and warrant the premium reductions, but others may not. Outside the SFHA, the NFIP does not require an elevation certificate for properties and also offers preferred risk policies[3] (PRPs) for properties that have a favorable loss

[3] Preferred risk policies can provide flood insurance coverage for both buildings and contents that are located in moderate to low flood-risk areas.

history. Neither premium is set using a rating table that considers first-floor elevation in relation to a BFE and, as such, cannot be an NFIP risk-based premium rate. BW 2012 does not direct FEMA to review and modify PRP and X zones, which are zones of moderate to low risk of flooding rates to make them risk based.

Finding 4.3. Full implementation of BW 2012 will not result in NFIP risk-based rates for properties located outside the SFHA.

ABILITY TO PAY

BW 2012, Section 100236 states that FEMA

> . . . shall enter into a contract under which the National Academy of Sciences, in consultation with the Comptroller General of the United States, shall conduct and submit to the Administrator an economic analysis of the costs and benefits to the Federal Government of a flood insurance program with full risk-based premiums, combined with means-tested Federal assistance to aid individuals who cannot afford coverage, through an insurance voucher program.

Even though the language in the committee's statement of task does not mirror the language in Section 100236, the committee did review Section 100236 to gain insights into the important questions being asked. For example, the phrase "cannot afford" can be understood as exceeding an individual's ability to pay an NFIP risk-based premium. This focus on ability to pay requires FEMA to define when such premiums impose a cost burden on an individual. Report 1 discussed three possible measures of cost burden, two of which were related to an individual's income. Specifically, Report 1 discussed an income approach and a housing cost as a percent-of-income approach to identify those who would be cost burdened by NFIP rate increases, as well as an approach suggested in HFIAA 2014 that identified premiums exceeding 1 percent of coverage as burdensome.

Cost Burden

During the preparation of Report 2 the committee continued to discuss different definitions of cost burden and ability to pay as it considered the data needed to build a microsimulation model module to estimate who would be eligible for assistance under various affordability policy options. In having that discussion, the committee developed new findings relevant to the topic, including the measure of cost burden suggested by HFIAA 2014—premium as a percentage of flood insurance coverage. The commit-

tee found that a property owner's income or wealth characteristics cannot be incorporated into the above-cited cost burden measure. For example, households with income of $500,000 and $50,000, but with the same coverage and premiums, would be considered equally cost burdened and, if a policy provided assistance to eliminate the entire cost burden, would receive similar amounts of assistance.

Finding 4.6. The use of premium as a percent of insurance coverage does not, by itself, satisfy the congressional directive to FEMA to consider providing "targeted assistance to flood insurance policyholders based on their financial ability."[4] Therefore, if ability to pay is the congressional concern, then FEMA will still need to develop a measure of cost burden based on policyholder income or wealth or both.

The committee's review of the capped premium approach to defining cost burden and its assessment of policy analysis data needs and gaps led the committee to consider the premium as a percentage of the assessed value of the insured property as an alternative measure of cost burden. Property value, which is a substantial component of total wealth for many households, is used as a proxy for wealth. Wealth, in turn, would be employed as a metric for defining ability to pay for flood insurance. Adding this cost burden measure means that the committee considered four different approaches for defining when NFIP premiums become unaffordable. Each of these approaches has both advantages and disadvantages.

Finding 4.7. For the purpose of implementing an assistance program, policy makers will need to decide whether they want to define cost burden with reference to income, housing costs in relation to income, premium paid in relation to property value, or some other measure. This decision can be informed by technical analysis of the alternatives, but the final selection is a policy judgment.

Loss of Property Value and Household Wealth

Some property owners prior to BW 2012 were eligible to pay PFS rates. Eliminating those rates will increase premiums and, in turn, lower property value. The committee was aware that reduction in property values was a frequently expressed concern of property owners and communities following passage of BW 2012. An argument made by some was that, in many cases, the property value was a substantial component of a policyholder's total wealth. Therefore, a premium increase that diminished property value

[4] HFIAA, Sec. 9(b)(2).

would, in turn, have a negative impact on wealth. HFIAA 2014 was the congressional response to these and other expressed concerns, but it too will result in the eventual elimination of PFS rates and reduced property prices.

The committee considered the possibility of analytically identifying the effects on property values of losing PFS rates. However, isolating effects of premium increase from other determinants of market price will be difficult, even if the best data for making such a calculation were available. The committee also considered policy options to mitigate these effects if they could be identified. One option to mitigate these effects would be to cap rates at a level less than NFIP risk-based rates for all PFS rates and also allow that cap on the premium to transfer with the property to all future owners. This would be without regard to the future owners' ability to pay. This option would be contrary to the goals of BW 2012 to have property owners pay NFIP risk-based rates and would result in lost revenues to the NFIP, unless offsetting increases in revenues were provided by the federal treasury or by cross subsidy. Another option would be for FEMA to offer financial compensation for property value loss when homeowners sell their house.

Finding 4.8. The negative effect on property values from allowing PFS rates to rise to NFIP risk-based rates is a market-driven reality but would be analytically difficult to isolate from other determinants of property price. A policy decision to compensate for some amount of property value loss may require public expenditure.

LINKING MITIGATION WITH PREMIUM ASSISTANCE

Report 1 described how assistance might be offered for making flood insurance premium payments, for paying for some or all of mitigation that can lead to reduced premiums, or for a combination of both. One way to link flood insurance premium assistance with flood mitigation is through providing an annual assistance payment that the property owner could use to cover the premium and implement mitigation through a long-term loan. If the property owner is expected to decide how to use an assistance payment, then owners should be provided with information on mitigation measures and the contributions of adopting such measures to premium reductions. This type of information is not currently available to homeowners and would require a new outreach and communication effort, especially if the NFIP offers premium reductions for mitigation actions in addition to elevating one's home (Report 1, Chapter 7).

An alternative approach would be for the NFIP to make the calculation to determine the most cost-effective flood mitigation measure for the policyholder and, if assistance was offered, the NFIP would require that cost-effective mitigation be implemented. The argument for this mandatory

use of assistance is that people lack the information to make a financial assessment of the value of mitigation, so a calculation would be made on a policyholder's behalf.

Finding 4.10. Linking mitigation with premium assistance can lead to property owners having a cost-effective combination of mitigation and insurance coverage. Identifying that combination, however, requires complex calculations and the roles and responsibilities of FEMA in assisting with that calculation need to be assessed and, potentially, enhanced.

A FINAL REFLECTION

Floodplains and coastal areas across the United States will continue to be inhabited, especially in places where ready access to water is essential to the economic activities of people and their communities. These geographic areas will sustain occasional damages from future riverine floods and coastal storms. The costs of these losses will be borne in three possible ways, or in some combination. One is that individual NFIP policyholders will bear location cost in the form of insurance premiums paid and damages falling within policy deductible amounts. The second is that the federal taxpayer might bear floodplain location costs if the federal treasury develops a premium assistance program, makes up for NFIP premium revenue shortfalls, pays for pre-flood mitigation, or makes post-flood disaster assistance payments to individual households. Third, property owners and other floodplain or coastal zone inhabitants will bear costs for the losses that are uninsured or otherwise uncompensated.

An original intent of the NFIP was to replace disaster aid payment with flood insurance purchase to the maximum extent possible, shifting more of the cost of floodplain location onto those persons who occupy such places (Report 1, Chapter 2). If this goal is to be pursued, then requests for premium assistance or pre-flood mitigation grants and loans may increase due to future possible premium increases and from changes in flood risk, stemming from changes in climate and changes in watershed runoff due to development. As an NFIP affordability framework is developed, FEMA and Congress will confront the central question, "Who will bear the costs of floodplain occupancy in the future?" With specific reference to the goal of "affordable premiums," that question will be answered in recognition of the available governmental budget for premium or mitigation assistance and the adherence to the actuarial principle of minimizing cross-subsidies within the NFIP.

1

Introduction

The National Flood Insurance Program (NFIP) was created in 1968 legislation and today is administered by the Federal Emergency Management Agency (FEMA). When the NFIP was authorized, Congress intended for the program to encourage community initiatives in flood risk management, charge insurance premiums consistent with actuarial pricing principles, and also to make premiums affordable to encourage the purchase of flood insurance by owners of flood-prone properties instead of relying on post-disaster flood aid (NRC, 2015a).

Flood insurance can be purchased by individuals from private insurance agents once their community participates in the NFIP and, in so doing, adopts minimum floodplain management ordinances (NRC, 2015a). Flood insurance policies can be bought directly from the federal government through an NFIP Direct Servicing Agent or from a FEMA-identified Write-Your-Own agent.

NFIP risk-based premiums depend on expected future insurance claims; these claims will depend on coverage selected, property characteristics, and the location of the property. In addition, there are charges added to the premium to cover the costs of administering the program and maintaining a financial reserve to cover catastrophic-loss years. However, from its inception, the NFIP premium structure has deviated from strict adherence to actuarial principles to promote the multiple and sometimes conflicting goals of the original authorization (Hayes and Neal, 2011; NRC, 2015a).

The NFIP has been reauthorized many times since 1968, most recently with the Biggert-Waters Flood Insurance Reform Act of 2012 (BW 2012). In this most recent reauthorization, Congress placed a particular emphasis

on the goal of setting premiums following actuarial pricing principles, motivated by a desire to ensure that future revenues were adequate to pay future claims and administrative expenses (NRC, 2015a). BW 2012 was designed to move the NFIP toward risk-based premiums for all flood insurance policies. The result was to be increased premiums for some policyholders that had been paying less than NFIP risk-based premiums, and to possibly increase premiums for all policyholders (NRC, 2015a).

Recognition of the possibility of increased premiums for some policyholders and broader affordability concerns of flood insurance is reflected in Section 100236 of BW 2012 (Appendix C), and in Sections 9 and 16 of the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA 2014) (Appendix D). These sections called on FEMA to propose a draft affordability framework for the NFIP after completing an analysis of possible options for offering "means-tested assistance" to policyholders for whom higher premium rates may not be affordable.

ORIGINS OF THIS REPORT

BW 2012 and HFIAA 2014 mandated FEMA to conduct a study. The legislation also called for FEMA to prepare a "draft affordability framework" as described in Section 9 of HFIAA. In developing the affordability framework, FEMA was to address several matters, only one of which is to propose an assistance program. The required content of the framework (paraphrasing the legislation) included

- a plan for offering targeted assistance for ensuring flood insurance affordability among low-income populations;
- programs to ensure communication of the flood risk to property owners and residents in floodplains;
- recognition of the effectiveness of a full range of individual and community actions to mitigate flood risk in NFIP rating tables;
- a report on the effect of increases in premiums on participation in NFIP; and
- a report on the consequences of map updates on affordability of flood insurance.

Section 100236 of BW 2012 also requested the National Academy of Sciences (NAS) to conduct a study that would "compare the costs of a program of risk-based rates and means-tested assistance to the current system of subsidized flood insurance rates and federally funded disaster relief for people without coverage" (P.L. 112-141; 126 Stat. 957). The reference to programs of "risk-based rates" and "current system" refers to comparing the premiums that would have been in place as a result of BW 2012 with

those before BW 2012. The comparison called for in the congressional request was to be for a time when BW 2012 was in full effect. The 2012 legislative requirement for a NAS study was amended by HFIAA 2014, changing the schedule and providing additional resources for conducting the study (NRC, 2015a).

There are some differences between language in the legislation and the scope of work for this report, and Report 1. As noted in Report 1, "when reading this report, it is important to recognize that the language from Section 100236 of BW 2012 as amended in HFIAA 2014 differs from the language in the statement of task. The language in the statement of task was discussed and agreed on by FEMA and the NAS with consideration of the resources available to the NAS and the needs of FEMA" (see Appendix I for the task statement of both reports).

The first report, entitled "Affordability of National Flood Insurance Program Premiums—Report 1," described policy options and decisions to be made as FEMA proposes an affordability framework. The summary of that report is included as Appendix A. Report 1 included chapters on the following:

- **Background and historical aspects of the NFIP.** Chapter 2 described the multiple goals for the NFIP, the initial responsibilities of the private sector, the legacy for current premium-setting practices, and the recent reform legislation.
- **Flood insurance pricing, policies, and premiums.** Chapter 3 reviewed NFIP premium-setting practices against actuarial pricing principles and explained the rationale for past deviations from those principles for the main types of NFIP policies (NFIP risk-based, pre-flood insurance rate map [FIRM] subsidized, grandfathered, Community Rating System discounted, and preferred risk). The text described how BW 2012 and HFIAA 2014 would affect future policy offerings and premium-setting practices.
- **The decision to purchase insurance.** Congress has long been interested in promoting the purchase of flood insurance and has continued (as evidenced in HFIAA 2014) to be concerned that higher premiums will discourage purchase. Chapter 4 reviewed the literature on the determinants of insurance purchase decisions and found that the effects of price on purchase was uncertain, but that premiums were one factor—however, not the only factor—affecting the decision to purchase flood insurance.
- **The spatial distribution of policy types and location of potential affordability challenges.** In Chapter 5, the limited policy data available were used to describe the number and distribution of NFIP policies of different types. Data limitations made it impossible to

determine how many polices were grandfathered, a matter of importance for affordability policy analysis.

- **Affordability concepts and a framework for assistance program design decisions.** Chapter 6 described three ways to measure when a premium might impose a cost burden on a policyholder and then described six design decision questions that policy makers must consider if they were creating an assistance program: who will receive assistance, what assistance will be provided, how will assistance be provided, how much assistance will be provided, who will pay for assistance, and how will assistance be administered? Technical analysis can provide valuable information, but the final answers to these questions require policy judgments.
- **Policy alternatives for an affordability strategy, including direct assistance options and actions that would reduce premiums for all policyholders.** Chapter 7 discussed specific ways to offer premium payment assistance and to offer premium-reducing mitigation assistance. For example, the chapter discussed changes to eligibility for mitigation grants. Another part of the chapter discussed alternatives to reduce premiums across the board. For example, the chapter discusses the opportunities and challenges of giving credit to mitigation actions other than elevation for reducing future claims and hence premiums.

This second report proposes an analytical platform and describes the data required for FEMA to use when evaluating the possible alternatives that might be included in an affordability framework. The committee's charge for this report—Report 2—is outlined in Box 1-1.

In developing the task statement, the NAS committee and FEMA were aware of substantial data gaps for the purposes of evaluating options for an affordability framework.

The committee's Report 1 concluded that the increase in premium costs to pre-FIRM properties from charging NFIP risk-based rates could only be estimated with additional data on structure elevations. There data are missing for pre-FIRM subsidized (PFS) policyholders, although FEMA is in the process of collecting it, and for polices located outside the special flood hazard area. The committee also found that there is a lack of data to identify whether a current policy is grandfathered. Other data gaps include floodplain property owners' household income, housing expenses (including mortgage obligations), and perhaps other characteristics for evaluating different means-tested assistance program designs (NRC, 2015a).

Lack of data for evaluating NFIP policy options has been recognized as a challenge in the past. In 1999, in response to the National Flood Insurance Reform Act of 1994, FEMA contracted with PricewaterhouseCoopers

BOX 1-1
Statement of Task

The Federal Insurance and Mitigation Administration is a component of the Department of Homeland Security, Federal Emergency Management Agency (FEMA), which operates the National Flood Insurance Program (NFIP). On March 21, 2014, President Obama signed the Homeowner Flood Insurance Affordability Act (HFIAA) of 2014 into law. This law repeals and modifies certain provisions of the 2012 Biggert-Waters Flood Insurance Reform Act and makes additional program changes to other aspects of the program not covered by that Act. One modification regards a study being conducted by the National Research Council (NRC) of the National Academy of Sciences. HFIAA requires the submission of the Affordability Study by the FEMA Administrator in 18 months from enactment of the Act.

The second report will propose alternative approaches for a national evaluation of affordability program policy options. The second report will include lessons for the design of a national study from a proof-of-concept pilot study. The second report shall discuss

- data issues such as needs, availability, quantity, and quality;
- appropriate analytical methods and related considerations, including models, computing software, and geographic areas to be analyzed;
- a proof-of-concept pilot analysis will be subcontracted as part of the study. This analysis will apply different methods for conducting a flood insurance affordability analysis for a state (North Carolina) in which data on elevations of structures and hydrologic flood hazards are readily available. This analysis will inform the committee's deliberations and findings regarding the possibilities for a national-level flood insurance affordability study, for which these data on elevations and flood hazards are less readily available; and
- national implications from the proof-of-concept pilot results including, but not limited to, possible impacts on participation rates (the analytical work for the proof-of-concept pilot may be carried out by the NRC directly or using subcontractors as necessary).

(PwC) for a study on the economic effects of charging actuarially based premium rates for pre-FIRM structures. The PwC report (PwC, 1999) tried to fill elevation data gaps by drawing a sample of pre-FIRM properties and then used sample results to impute missing values to the whole population of pre-FIRM properties including first-floor elevation. Because of study time and cost limitations, a sample of 50 communities that included pre-FIRM subsidized policies (a sample from 15,461 NFIP communities considered in the study) was selected. Elevation data were collected on structures in 23 of the 50 communities. It is not clear from the report the extent to which these

samples were representative of the entire population of NFIP communities. No new effort to secure elevation data was initiated and the 16-year-old results for the PwC report continue to be used to estimate the elevation of pre-FIRM properties in 2015.

More recently, the Government Accountability Office (GAO) and Congressional Research Service reported on various aspects of the NFIP. These included the challenges and financial status (King, 2012), improving the administration of the NFIP (GAO, 2011), subsidized properties (GAO, 2013), and strategies for improving the role of the private sector (GAO, 2014a) (see Appendix A for further description of the reports). In 2014, GAO also reported on forgone premiums—the difference between subsidized and full-risk premiums. As of the end of September 2013, there were more than 1.1 million subsidized policies (GAO, 2014b). GAO found that forgone premiums could not be measured, as there was a lack of property elevation data for PFS policyholders. Nonetheless, GAO did estimate how much forgone premiums might be and this ranged between $16 and $25 billion for the period 2002 to 2013 (GAO, 2014b). To do that, they relied upon estimates provided by FEMA (which in part are based on the elevation data reported in the 1999 PwC study).

The reality of limited data and little analytical capacity to quantitatively determine outcomes of different flood insurance affordability policy options is the context for this report. Importantly, the recognition that data gaps would not be easily filled directed the task statement for Report 2 toward a report on analytical process design, data gap identification, and approaches to filling data gaps.

REPORT 2 ORGANIZATION AND AUDIENCE

Responses to the questions implied by Congress in BW 2012 and HFIAA 2014 are being developed by FEMA in a context of no existing analytical platform and significant data gaps (see NRC, 2015a; GAO, 2013; and King, 2013). Chapter 2 of this report describes various models with a focus on a microsimulation approach to policy analysis for the NFIP that can be structured and scaled to the available time, cost, and data resources and then enhanced as more resources become available. This analytical approach, considered in the context of questions that need to be answered for an affordability framework, provides a basis for understanding data requirements. Chapter 3 then discusses the available data both in the NFIP policy database and from other sources both in and outside of FEMA. Presently, much of the data needed for simulation are not available; therefore, Chapter 3 also reports on ways to fill those data gaps. Within Chapters 2 and 3, the committee makes reference to a report prepared by the North Carolina Floodplain Mapping Program. This report used the analytical

method of microsimulation to evaluate affordability policy options and, in so doing, served as a proof-of-concept for that method and helped identify data needed to perform affordability policy analyses. Chapter 4 has two main sections. The first includes suggestions for near-term analysis that can be accomplished with existing or modestly expanded resources and data. In the process of preparing its second report, the committee had the opportunity to reflect on the findings of Report 1 and, as a result, developed additional findings (all findings are in boldface type and the numbering of findings reflects chapter number and sequence in the respective chapter) for consideration by FEMA as it prepares its affordability framework for Congress. Therefore, Chapter 4 includes additional findings for some of the topics covered in the different chapters of Report 1. Each chapter presents its findings in the body of the text or at the end of the chapter or both. The report summary includes select finds from Chapters 2, 3, and 4.

Appendix A is the Summary from Report 1. Appendix B is a table of past pertinent reports undertaken by the Government Accountability Office and the Congressional Research Service between 2011 and 2015. Appendix C is Section 100236 from the Biggert-Waters Flood Insurance Reform Act of 2012, and Appendix D is Section 16 of the Homeowner Flood Insurance Affordability Act of 2014. The committee biographical sketches are in Appendix E. Appendix F is a letter sent to the committee requesting evaluation of the specific cost burden measure suggested in HFIAA 2014. Appendix G is a table of data products from the American Community Survey, Appendix H includes tables of data fields found in the NFIP database, and Appendix I includes the task statements for Report 1 and Report 2.

The audience for this report includes FEMA; other relevant federal agencies, such as the U.S. Department of Housing and Urban Development (HUD); Congress and congressional staff; governors of states with flood-prone communities; mayors and citizens in flood-prone communities, especially NFIP policyholders; university faculty and other experts in the fields of natural hazards, flood insurance, and floodplain management; local and state officials with NFIP implementation responsibilities; and private-sector companies involved in flood insurance, flood mapping, and floodplain management.

2

An Approach to Policy Evaluation for the National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) was directed by Congress to conduct a study on how changes required by the Biggert-Waters Flood Insurance Reform and Modernization Act of 2012 (BW 2012) affect the affordability of flood insurance premiums. Such a study could support the design of a National Flood Insurance Program (NFIP) affordability framework that includes a financial assistance program, as specified by the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA 2014), Section 9. The committee's first report (NRC, 2015a) described policy options that might be considered in proposing an affordability framework and also the design decisions that must be made by policy makers to develop an affordability assistance program. The various options can be combined in different ways to formulate a wide range of policy option alternatives. This chapter is organized in consideration of needing to choose among these policy option alternatives. It has three major sections: elements of a planning process; a discussion of policy modeling, including microsimulation; and an illustrative application of a planning process to evaluate affordability policy options.

ELEMENTS OF A PLANNING PROCESS TO EVALUATE AND COMPARE NFIP POLICY OPTIONS

A structured planning process for conducting the congressionally required affordability study can be organized around a suite of interrelated evaluation elements (Deason et al., 2010; Stokey and Zeckhauser, 1978). These elements are briefly described below and are generally executed in a

stepwise fashion, but the process can be iterative to provide opportunities for revisiting and refining steps to formulate a given alternative option.

1. Identify problems and opportunities. The evaluation process begins by identifying policy-relevant questions and outcomes. Most of the questions will be of the "what-if" nature, organized around a policy problem to be addressed by as yet unspecified policy options. For example, a what-if question would be the following: For how many policyholders would a particular assistance program eliminate the cost burden of NFIP risk-based premiums under full implementation of BW 2012? In the NFIP context, these could include the number and percent of policyholders who are cost burdened by their NFIP premiums using different measures of cost burden selected by policymakers for comparison.

2. Forecast future conditions. With the first element completed, a forecast of the future level of each metric without any policy interventions is prepared. In the context of BW 2012 Section 100236, this future condition would be BW 2012 fully implemented, without an associated affordability policy. This is the baseline for the analysis as discussed in this report.

3. Formulate policy options. The next step is formulation of alternative policy options that might affect metrics in the future. Report 1 (Chapters 4, 6, and 7) discussed actions to increase takeup rates and affordability policy designs that might reduce the cost burden of NFIP premiums.

4. Predict future conditions with an alternative policy option in place. The analytical and generally quantitative element then follows, wherein models and data are used to predict conditions under the baseline and with the policy options. For example, to assess the effect of a mitigation loan program, the number and percent of policyholders who would be cost burdened under the loan program could be estimated and compared to the number and percent values predicted under the BW 2012 baseline.

5 and 6. Evaluate and compare policy options. With all predictions made, the results are displayed in ways to allow decision makers to evaluate and compare options and, ultimately, choose a preferred policy option. Ideally, implementation of the chosen option is followed by monitoring of outcomes to ensure that policy-relevant concerns are being addressed; this will mean that important metrics (e.g., number and percent of policyholders who are cost burdened) are measured and tracked to assess the status of a given option.

MODEL DEVELOPMENT FOR EVALUATING AFFORDABILITY POLICY OPTIONS

Policy Modeling: What If?

A common charge to federal agencies from executive and legislative policy makers is to provide quantitative answers to questions about the likely future effects of one or more policy options in a "what-if" framework: If a policy changes in a specified way, what is an agency's best estimate of not only the total costs to the government compared with current policy 1, 5, or 10 years out, but also who will benefit and who will lose from the change—which population groups, geographic areas, and organizational players? Any such analysis, no matter how simplistic, requires the development, implicitly or explicitly, of a model that makes assumptions and applies them to data to generate estimates.

One definition of a quantitative model is a "mathematical framework representing some aspects of reality at a sufficient level of detail to inform a clinical or policy decision" (Caro et al., 2012). More generally, a model is a communication tool that allows the complexity of a given system to be reduced to its component elements. Models range from simple to highly complex (Box 2-1). Models can be ad hoc—developed for one-time use, often "on the fly"—or they can be formal—developed for longer-term use for repeated evaluations of alternative policy options as they emerge in an area and, hence, requiring extensive documentation of assumptions, inputs, outputs, and modeling processes. Model outputs can range from aggregates for a few categorizations of the population of interest, to detailed disaggregation by areas or population subgroups. Model inputs can similarly pertain to a relatively small number of prespecified aggregations or to large numbers of individual observations that can be reaggregated in different ways. Model operations can be largely deterministic, or they can be probabilistic and include behavioral predictions based on empirical studies. Models can also accomplish future projections by "aging" the initial database and incorporate changes in key parameters due to external forces (e.g., sea-level rise due to climate change).

Prior to the advent of high-speed computers and extensive databases, modelling analysis was limited to simple, deterministic, highly aggregated, ad hoc models that could be computed on the "back of the envelope." Beginning in the 1960s and 1970s, several types of formal computer modeling techniques and software were developed for longer-term use. Today, ad hoc models developed for specific applications often use software that utilizes tabular spreadsheets.[1] Tabular spreadsheets could be considered the

[1] Spreadsheets can also be used to develop some types of formal models.

BOX 2-1[a]
Types of Policy Analysis Models and Their Applicability to the NFIP

Time-Series Models—Models that range from simple extrapolation of a time series, such as participants in a program (e.g., the number of policyholders) or aggregate annual claims, to complex macroeconomic models that interrelate large numbers of time series with specified assumptions about, for example, the relationship of economic output to various inputs. With their focus on forecasting aggregate quantities based on historical data, simplistic time-series models are too limited for policy modeling of the NFIP, and complex macroeconomic models are not applicable.

Regression Models—Models that include parameter estimates of the relationships of input (right-side) variables to an output (left-side) variable from a regression performed on a database; for example, a regression model might be useful to relate the probability of participating in a flood mitigation program to characteristics of homeowners. Regression models are too limited for most policy modeling, including that required of the NFIP. One such limitation is the ecological fallacy—the logical error of making inferences about individuals (e.g., policyholders) from relationships estimated for groups (e.g., communities). Another limitation is the complexity of modeling many outcomes together. Nonetheless, appropriately specified and estimated regression models can often provide one source of input to another type of model (e.g., a microsimulation model).

Cell-Based Models—Spreadsheet models that perform computations on prespecified "cells." For example, NFIP policyholders might be classified by premium category prior to BW 2012 (e.g., NFIP full-risk, pre-flood insurance rate map [FIRM] subsidized, grandfathered), elevation, amount of coverage or property value, broad geographic area of property, and other characteristics. The cell-based

functional equivalent of yesterday's "back of the envelope" calculations, although spreadsheets can also be used in more formal models. Among the available formal modeling techniques are time-series models, regression models, cell-based models, microsimulation models, and general equilibrium models (See Box 2-1). Numerous computing software packages have the capability of undertaking many of the modelling techniques listed below.

In considering modeling options, FEMA could view its congressional directive—that is to conduct a study on how BW 2012 would affect the affordability of flood insurance premiums—as limited to requiring the development of one or more ad hoc models for estimating costs and benefits of specific affordability policy options. However, if FEMA views its Congressional request in the context of a long history of requests for different kinds

approach could be useful for the NFIP—for example, assessing the effect of a very specifically targeted policy (e.g., providing affordability assistance based on a simple formula to policyholders that received pre-FIRM subsides prior to BW 2012). However, a cell-based model would limit the detail of disaggregation of outputs that could be provided to policy makers and would likely require frequent respecification to add, delete, and modify cells as policy options (e.g., assistance targeting) and output needs changed.

Microsimulation Models—Models that operate on microlevel databases of individual records (e.g., policyholders), mimicking how current and alternative program provisions apply to the individual units described in those records. Such models permit detailed disaggregation of outputs to serve policy makers' diverse needs. Although microsimulation models are often complex (but typically less complex than macroeconomic models) and can be costly to build and maintain, such a model would be highly flexible and well suited, and relevant to the policy modeling needs of the NFIP.

Computable General Equilibrium Models—As their name implies, models that simulate entire economies, which are typically disaggregated into sectors, and are designed to estimate the general equilibrium effects—after several rounds—of major economic policy changes (e.g., changes in taxes). They are not applicable to the NFIP, which pertains to a tiny part of the U.S. economy. Similarly, integrated assessment models, which are used to model the interaction of environment factors, such as climate change, economic impacts, and large-scale policy responses (Nordhaus and Sztorc, 2013), are much too broad for use for the NFIP.

[a] Although Report 2 focuses on the applicability of these techniques for policy modeling of the NFIP, more general discussions of these methods and their strengths and weaknesses for other applications can be found in NRC (1991, 1997) and OASPE (2012).

of analysis (See Appendix B) then it may choose to pursue the development, maintenance, documentation, and regular updating of a formal policy modeling tool that can be used repeatedly to analyze a variety of policy options and the effects of changing external conditions. The task for FEMA then becomes determining which formal modeling tool (or tools) to select for investment given the kinds of policy questions it is likely to be asked.

FEMA's modeling needs for NFIP premium affordability study require the ability to estimate yet-to-be developed policy options, singly and in combination, that could affect NFIP premium revenues and the affordability of premiums for current individual policyholders and groups of policyholders (defined, for example, by income or wealth, geographic area, and other characteristics) and potential policyholders. Congress and other

stakeholders may want answers to questions that have a specific focus, such as, What are the effects in a particular congressional district for various groups of property owners and where are the effects concentrated? As FEMA's modeling capacity is developed over time, the agency would be able to predict behavioral effects, such as the propensity for homeowners to newly purchase, increase, decrease, or entirely drop flood insurance coverage in response to changing premiums or assistance in paying premiums or undertaking mitigation. This combination of analytical requirements leads to consideration of microsimulation techniques for assessing NFIP policy options, including options for providing affordability assistance.

Regarding this choice, the committee began with the reality that the effects of BW 2012 (and other legislation and policies) are manifested first at the level of the individual policyholder/property owner. Therefore, the most appropriate and credible analytical approach has to begin at that level, and the only such approach for highly flexible, fine-grained, realistic analysis is microsimulation. In addition, microsimulation is the only approach that readily allows results to be presented for various levels of aggregation, as is typically required by policy makers. Of course, as the report notes, FEMA will need to consider its current directive from Congress and its mission and long-term objectives, as well as time, the availability of resources, and other factors in making a decision on modeling strategies. FEMA may determine that other modeling approaches (e.g., cell-based models) can be useful for some limited questions and purposes. But the committee does recommend microsimulation to FEMA on the assumption that FEMA will continue to be asked for detailed analysis of costs and benefits of various proposals for changes in the NFIP or other policies (e.g., disaster relief or mandatory purchase requirements), so that an investment in microsimulation is well worth it. Moreover, microsimulation analysis would likely be conducted on a sample of households and properties, and the size of the sample deemed adequate for answering the policy questions being raised will feature heavily in determining the cost and time for obtaining needed data completing cost-benefit analyses of various policy options.

A fully developed microsimulation model can be complex and can be costly to build and maintain. However, a complete microsimulation model does not need to be built before any analyses can be completed. Rather the construction of the model can begin immediately by building separate modules and as the available data permit can be used to answer some important but limited questions. Over time new modules can be built and linked together to create a more complete model that can be quickly deployed to answer future NFIP policy questions as they arise.

What Is Microsimulation?

The microsimulation modeling approach to produce estimates of the effects of proposed changes in government programs involves obtaining inputs from microlevel databases of individual records, mimicking how current and alternative program provisions apply to the individuals described in those records. For example, in simulating the effects of changes to the Supplemental Nutrition Assistance Program (formerly the Food Stamp Program), microsimulation models process records for families as if they were applying to the local welfare office for benefits, and in simulating the effects of tax law changes, microsimulation models process records for people as if they were filling out their 1040 tax forms.[2]

Microsimulation models have two essential elements: (1) a microdatabase and (2) a computer program. The database is constructed from administrative or survey data with information on households in the population targeted by the government program. The model's computer program codes the rules of the government program under both the "baseline" policy, which is typically the current policy, and a "reform" policy, which is a proposed alternative. The computer program also simulates, in the case of a government assistance program, whether a household is eligible for the government program and the benefits for which the household would qualify. In addition, the computer program simulates a household's behavioral response, determining whether the household will participate in the program. Processing all the households in the database, the model counts participants to estimate the total participation in the program and adds up the assistance provided to estimate total program costs. By performing these operations under both baseline and reform policies and comparing the results, the model estimates the program cost and participation effects of the proposed reform policy option. The model can also estimate the distributional effects of the reform, identifying the population subgroups that gain and lose benefits (Schirm and Zaslavsky, 1997).

For the NFIP, a fully developed microsimulation model would likely have a database consisting of current NFIP policyholders and potential policyholders—in other words, both insured and uninsured properties—in areas of flood risk. For each property in the database, the computer simulation program would use location information, property characteristics, and preferred coverage to simulate premiums to be paid under a baseline and a proposed alternative policy option. Information on the assistance program design features, the property, and the property owner will allow the computer program to simulate whether the property owner is eligible for assistance (and the amount of assistance) in paying the premium or for

[2] Commercial tax preparation software is a form of microsimulation modeling.

undertaking mitigation. The program would also be able to aggregate the simulated results across properties in the database to estimate outcomes such as the insurance takeup rate, NFIP net revenues, and federal expenditures. Also, effects on subgroups defined by property or policyholder characteristics, including geographic area, premium category prior to BW 2012 (NFIP full-risk, pre-FIRM subsidized [PFS], grandfathered, and preferred risk policy) and household income or wealth could be estimated (see Box 2-2).[3]

Typically, microsimulation models are developed incrementally, with continuing improvements to both the database and computer simulation program over time. The simulation program is usually modularized, and the simulated results from some modules feed into other modules. Such modularization facilitates the refinement of old modules and the addition of new modules to enhance the model's simulation capabilities. In addition to simulation modules, the program will have basic tabulation routines that aggregate across individual observations in the database to produce estimated outcomes for the entire NFIP and important subgroups.

For the NFIP, an initial microsimulation database might include only current policyholders. Through time, properties that are not covered might be added to the database. Similarly, the first-generation model might not simulate behavioral responses, assuming, instead, that current policyholders maintain the same level of coverage as before even if the premium were to change substantially. Subsequently, a behavioral response module could be developed that simulates whether a current policyholder increases, decreases, or drops coverage and whether a potential policyholder takes up coverage on a previously uncovered property in response to a change in the premium, considering the current or potential policyholder's income and other characteristics.[4]

Although the first-generation NFIP microsimulation model might not simulate behavioral responses, it would certainly need a module that estimates a property's flood risk based on the property's characteristics, as well as a module that estimates the flood insurance premium based on the NFIP

[3] Output from the microsimulation program could include, for example, premium revenues and the percentage of policyholders who are cost burdened by their NFIP premiums, for not only the entire NFIP, but also the subgroup of policyholders who lost pre-FIRM subsidies due to BW 2012. These outcomes would be estimated under both the baseline condition and the alternative policy option under consideration. The differences between the outcomes—such as the increase or decrease in the percentage of cost-burdened policyholders—show the effects of the alternative policy option.

[4] Pending the development of such a behavioral response module, a microsimulation model could have the capability of conducting sensitivity analyses based on certain—probably fairly crude—assumptions, such as no response at all versus no response at all except for dropping coverage entirely if the premium increase exceeds some specified threshold.

BOX 2-2
A Microsimulation Model of the NFIP

A microsimulation model operates on a microlevel database of individual records (e.g., property owners in floodplains) and simulates how current program provisions and alternative policy options affect these individual records.

The essential elements in developing a microsimulation model of the NFIP include the following:

1. Construction of a microdatabase of properties, policies, and owners with all the relevant data elements, including hazard maps or other means to estimate flood losses and future claims should floods of different magnitudes occur and cause damage to properties.
2. Development of a computer program that can simulate a baseline policy (e.g., BW 2012 as fully implemented) and alternative policy reforms (e.g., an affordability assistance plan). The program would perform all of the necessary calculations to show "what happens" to a property owner or to other entities of interest (an entire community or other relevant subgroups) under the baseline and under alternative options. As it is developed, FEMA's microsimulation model could incorporate projections of the baseline into the future based on changes in the population (e.g., aging and development) as well as changes in external conditions (e.g., sea-level rise due to climate change).

Microsimulation models are conceptually attractive because they begin at the appropriate decision level of the property and property owner and can account for the diverse circumstances and characteristics of the relevant population. In FEMA's case, the relevant population may be current NFIP policyholders and potential policyholders in areas of flood risk.

rating tables (or the tables under an alternative plan), the chosen coverage and deductible, and the estimated risk from the risk module.[5] Meanwhile, the microsimulation database would need to have all of the data elements required by these modules. These data needs and the gaps in existing data are discussed in detail in Chapter 3.

Of course, the reform options of most immediate interest to FEMA are affordability assistance programs, such as a program that provides premium assistance to policyholders who are cost burdened by NFIP risk-based premiums. If the assistance is paid from general federal revenues, the

[5] The analysis called for by BW 2012 is pushing the NFIP rate-setting practice toward "full-risk" premiums on all insured properties. Therefore, the premium determination module must be able to mimic the process by which premiums are estimated.

BOX 2-3
Projection Capabilities in Microsimulation Models

Because federal, state, and other agencies are often asked to provide estimates of policy effects for future periods, any modeling tool requires a capability for projection of its input database. Projection capabilities in microsimulation models are achieved by two basic techniques: static aging and dynamic aging.

Static microsimulation models project a sample forward for short time periods by reweighting the records in the database (e.g., if new construction in an area is expected to increase at-risk properties by 10 percent over the next 5 years, then the properties in the database in that area are treated as if they each represented 1.1 properties).

Dynamic microsimulation models project a sample forward by dynamic aging (e.g., people aged 50 become 60 in year t + 10). FEMA may not need the added complexities of dynamic aging, because it is not concerned with following the trajectories of individual policyholders. Rather it is concerned with point-in-time estimates for specified periods (e.g., 5 or 10 years into the future). Such estimates can be accomplished by static reweighting techniques.

effect of the assistance program on NFIP premium revenues is limited to its effect on whether the premiums paid by those who receive assistance change their demand for insurance, a response that might not be simulated by a first-generation model. Yet, if the assistance program design caps premiums paid to the NFIP, revenues to the program would be reduced. In either case, one or more modules may be needed to determine which policyholders are eligible for assistance, the amount of assistance to be provided, and how the amount of assistance is paid (whether by reducing the premium or from an "outside" source). Additional modules or enhancements to other modules might be required if assistance programs providing mitigation assistance are to be simulated. For example, it could be necessary to simulate how a particular mitigation activity lowers flood risk and, thereby, the flood insurance premium (Box 2-3).

Moving Forward

FEMA will need to determine what it seeks to accomplish with any modeling it undertakes. At one extreme, it might see its needs met by a model with limited capabilities to answer immediate and specific questions about affordability policy options. For example, FEMA may choose to estimate only the effects of a policy that provides some or all previous recipients of PFS rates with assistance amounts equal to their pre-FIRM subsidies.

In contrast, FEMA might aspire to develop a microsimulation capability for providing rapid responses to a wide array of questions over time, including questions about program design that have not yet been asked (see Table 2-1 in section entitled "Identify Policy-Relevent Questions").

Models based on microsimulation techniques are conceptually highly attractive because they operate at the appropriate decision level (e.g., household or individual) and take into account the diverse circumstances and characteristics of the relevant population, whether it be low-income families or taxpayers, or, in FEMA's case, NFIP policyholders and potential policyholders in areas of flood risk. Such models are able to respond to important needs of the policy process for information about the effects of very fine-grained, as well as broader, policy changes, and the effects of policy changes on the NFIP as whole, as well as important population subgroups.

Building microsimulation models, however, which are necessarily complex to reflect the complexities of government programs and individual circumstances, requires substantial time and resources. There are recognized practices for an agency looking to develop a simulation model to address its needs for evaluating various policy options (NRC, 1991; OASPE, 2012, and the references on pp. 74-75 therein). These include

1. setting clear goals and priorities;
2. building capacity incrementally through time, especially as new and better data become available;
3. focusing on building self-contained modules that can be readily added to or removed from the model;
4. designing modules to facilitate documentation and validation and allow for enhancement over time;
5. being cognizant of the need to provide for entry and exit points in the model that facilitate linkages with other models, even if at some future date;
6. constructing prototypes and establishing milestones throughout the development process to help identify design flaws at an early stage;
7. enabling some analysis capabilities before the entire model is completed;
8. attaining model accessibility to allow for peer review and other users who are not experts;
9. preparing adequate documentation on a timely basis for the model and its components; and
10. conducting validation studies of the model and its components, including the assessment of uncertainty through the use of sensitivity analysis and the application of sample reuse techniques to measure variance.

Following these recognized practices will allow for the development of a well-documented and modularized microsimulation model. In adopting these practices, an agency is required to make clear the assumptions (tested and untested) in the model, the strengths and weaknesses of model components and the underlying data, and the relationships among model components. Such transparency helps develop a short-term and longer-term agenda for research and data acquisition to improve the model, which, in turn, improves the estimates of policy outcomes it provides.

MICROSIMULATION MODELING FOR THE NFIP

The purpose of this section is to illustrate how the evaluation elements might be implemented in a FEMA evaluation of affordability policy options. It is illustrative and not meant to be a recommendation for how

BOX 2-4
North Carolina Proof-of-Concept Pilot Analysis

The North Carolina Floodplain Mapping Program (NCFMP) prepared a report[a] that served as a reference for the Committee on the Affordability of National Flood Insurance Premiums. NCFMP conducted analyses, as instructed by the committee, relevant to the committee's charge and the analyses were considered by the committee in writing Report 2.

The NCFMP work focused on the analytical challenges, data needs, and related data acquisition issues for conducting a national-level flood insurance affordability assessment. NCFMP was selected to work with the committee in this "proof-of-concept" pilot analysis because of the extensive and sophisticated databases and analytical models developed by the state to assess flood risk. By many measures, the NCFMP databases and related methods of analysis are the most advanced in the United States, although they still fall short in some respects of what might be needed eventually by FEMA.

The NCFMP's report demonstrated an analytical approach and identified data requirements for evaluating different NFIP policy scenarios, with specific attention to policies that would limit premium increases (premium assistance or mitigation grants) for some subset of policyholders. As a part of the study process, this committee provided the scope of work that resulted in the NCFMP report. The NCFMP report, however, is not a committee product, rather a report that the committee references throughout Report 2.

The main objectives of the pilot analyses were to

1. test the conceptual logic and computational methods for an affordability analysis and
2. identify data needs to perform similar analysis at a nationwide scale.

FEMA might conduct a particular analysis. In preparing these sections of the chapter, the committee provided specific illustrations for each of the six elements of the planning process that are pertinent to applying a micro-simulation approach to the NFIP. The particular illustrations used are based on the committee's experience in preparing both Report 1 and Report 2, along with insights gained from the North Carolina proof-of-concept pilot analysis (NCFMP, 2015; Box 2-4). As FEMA begins to implement its own analysis, it will have to define the relevant questions, outcomes and metrics to measure outcomes, and alternative policy options to evaluate.

Identify Policy-Relevant Questions

A common charge to federal agencies from executive and legislative policy makers is to provide quantitative answers to questions about likely

To accomplish objectives, NCFMP had three tasks:

1. Compile and integrate relevant data.
2. Establish a baseline flood insurance portfolio for North Carolina.
3. Evaluate alternative NFIP policy options and their impact on affordability.

NCFMP has acquired and developed advanced datasets and tools to support its ongoing and planned initiatives on floodplain mapping. Examples of specialized datasets include building footprints, which have detailed physical building and property information, floodplain mapping, and digital flood elevation data. Other examples include methods for calculating building-level flood damages, mitigation costs, and flood insurance premiums. NCFMP uses these advanced datasets and tools to support management of all regulatory and nonregulatory flood hazards and other risk management data in a database-derived, digital display environment.

These activities conducted by the NCFMP demonstrate that it is possible to acquire additional data for policyholders (beyond the data that FEMA has available) and data for properties that are not insured. The proof-of-concept pilot analysis further demonstrated that it is possible to use such data to simulate the replacement of pre-FIRM subsidized and grandfathered premiums by NFIP risk-based premiums and the targeting and costs of affordability assistance based on a very simple (but not recommended) measure of cost burden.

[a] The NCFMP (2015) report is publicly available at http://dels.nas.edu/resources/static-assets/wstb/miscellaneous/wstb-cp.pdf.

future effects of one or more policy options in a "what-if" scenario. For example, if a policy changes, what is an agency's best estimate of the effects compared with maintaining the current policy 1, 5, and 10 years into the future?[6] To make such evaluations requires defining the objectives by which each option will be evaluated. This is an exercise that begins with the first element in the planning process—identifying problems and opportunities—but can be adjusted and clarified throughout the process. Any such quantitative analysis requires the analyst to understand the policy-relevant questions.

One approach is to identify evaluation objectives that are explicit or implicit in the questions being asked by decisionmakers. For the NFIP, this refers to the leading question posed by BW 2012 Section 100236, which is generally how to provide assistance (or make other reforms) that reduce the cost burden of an NFIP policy on owners of properties in flood-prone areas, as the legislation moves the NFIP toward risk-based pricing. This general concern can lead to a large number of more detailed questions as shown in Table 2-1. Table 2-1 includes illustrative examples of the questions posed during the course of the study by guest speakers, iterative discussions with FEMA, and other sources such as studies and reports from the Government Accountability Office (GAO) and the Congressional Research Service (see Appendix B). Questions can be either descriptive or of the "if-then" type. Such questions can give some guidance as to what kind of analyses might be needed to answer the questions being asked.

To conduct the required affordability analysis, FEMA will need to narrow down from the many possible descriptive and "if-then" questions into a more limited number of questions that can focus the analysis of alternative policy options and be used to define metrics for measuring the most critical program outcomes. These metrics will then serve as the basis for estimating the effects of each alternative option relative to the baseline and for comparing the alternatives against each other according to the policy objectives embodied in the metrics. Making reference to Table 2-1 and keeping the provisions of BW 2012 including Section 100236 in mind, one possible set of questions following from Report 1 might be the following:

- Does an assistance program reduce the number of policyholders who are cost burdened and the degree to which they are cost burdened (relative to BW 2012)? (Report 1, Chapter 6)
- Is an assistance program consistent with actuarial pricing principles, including NFIP revenues that cover claims and expenses through time, and does it provide transparency of grandfathering, discounts, and subsidies, and minimize cross subsidies? (Report 1, Chapters 2 and 3)

[6] This also means that objectives, or at least the emphasis on particular objectives, may vary over time.

TABLE 2-1 Examples of Affordability Specific Questions

Descriptive Questions Characteristics of the flood insurance program, as it existed before BW 2012, or as it is expected to exist after implementing BW 2012.	• How many existing policyholders paid pre-FIRM subsidized rates? Where are these policyholders located? • How much is the difference between pre-FIRM premiums and NFIP risk-based premiums for various subgroups of policyholders? • How many policies are grandfathered? Where are these policyholders located? • How much less are grandfathered premiums than NFIP risk-based premiums for various subgroups of policyholders? • What percent of buildings in the nation's floodplain have an NFIP policy? • How many buildings that have a federally backed mortgage and are located in a special flood hazard area do not carry an NFIP (or equivalent) flood insurance policy?
If-Then Questions The effects of an alternative policy option relative to the baseline of BW 2012. (These effects may or may not include behavioral responses, depending on the analytical capabilities of the microsimulation model.)	• If all policyholders who lost pre-FIRM subsidies received premium assistance under various assistance formulas, what would be the annual costs of such assistance? • If a subset of policyholders who lost pre-FIRM subsidies received premium assistance under various eligibility criteria what would be the annual costs of such assistance? • If mitigation assistance—loans or grants—was provided to all policyholders who lost pre-FIRM subsidies, what would be the annual costs of such assistance? • What changes would be expected in NFIP risk-based rates if FEMA added a loading for catastrophic loss coverage? • If grandfathering was continued into the future, in the face of increased flood risk in some watersheds (changes in watershed hydrology and hydraulics from climate change and land development), what are the consequences for adhering to actuarial pricing principles and for NFIP net revenues? • How would a particular premium assistance program affect takeup rates and, thus, compliance with mandatory purchase requirements among those who are required to purchase flood insurance? • How would a particular mitigation assistance program affect property values?

- What is the effect of an assistance program on takeup rates, including compliance with mandatory purchase and securing increased purchase by property owners who currently do not choose to purchase insurance? (Report 1, Chapters 2 and 4)
- What are the costs to the federal treasury of an assistance program? (Report 1, Chapter 6)[7]

For purposes of evaluating alternative policy options, questions such as these can be used to define metrics, so that the effect of a policy option (relative to the baseline) on each metric can be simulated. The metrics chosen will be logically connected to the policy questions and objectives and easily understood by decision makers and stakeholders. As an example of such an approach, NCFMP used the questions and associated metrics shown in Table 2-2 to structure and conduct the proof-of-concept pilot analysis.

This table is not an illustration of a complete ideal set of outcome metrics, but rather is only presented as an illustration from the proof-of-concept analysis. In fact, data gaps, which are discussed in detail in Chapter 3, may limit what outcomes can be predicted. For example, one of the long-standing concerns of Congress has been the takeup rate of flood insurance and how that takeup rate might be affected by higher premiums. No simulation to answer that question was done in the proof-of-concept analysis, because there was no behavioral response equation that could be used to predict the effect of higher premiums on takeup rate. Another challenge may be defining a measurable metric for a qualitative concern (see Box 2-5).

Specify Future Baseline Conditions

Analysis of flood insurance affordability policy options would define a baseline that can be used to evaluate the effect of alternative affordability policy options. The BW 2012, Section 100236, language suggests that the baseline is a situation where BW 2012 is in full effect. Adopting this baseline would require specification of what this means specifically in terms of rates for various classes of policyholders. This may not always be clear. For example, BW 2012 directs FEMA to evaluate the purchase of private reinsurance. The outcome of such an evaluation is not yet certain. As a result, one possible future condition is that there is a new load on all

[7] These questions are related to—but do not replace—the six decision questions that policy makers must consider when designing affordability policy options (Report 1, Chapter 6). Potential answers to some of those six questions will undoubtedly be informed by descriptive and simulation analyses (showing, for example, the numbers and characteristics of policyholders who are cost burdened under BW 2012).

TABLE 2-2 Illustrative Evaluation Questions and Associated Metrics

Evaluation Question	Metric Description
How cost burdened are policyholders?	Number and percentage of all policyholders who will be cost burdened based on the definition chosen by policymakers.[a]
	Number and percentage of policyholders who previously paid pre-FIRM subsidized rates who will be cost burdened.
	Number and percentage of current policyholders who would lose grandfathered rates who will become cost burdened.
	Number of property owners in 500-year floodplains, who do not have a policy, and for whom purchase of an NFIP risk-based policy will create a cost burden.
Does NFIP pricing follow actuarial principles regarding net revenues and cross subsidies?	Expected NFIP premiums minus the sum of expected claims and expenses.
	Percent of all revenue from explicit across-the-board loadings to compensate for forgone revenue.
What is the effect on federal treasury spending?	Expenditures made for a premium assistance program.
	Expected spending for post-flood disaster aid.

[a] In the North Carolina proof-of-concept analysis, cost burden was defined as when premiums exceeded 1 percent of flood insurance coverage. This measure was used because data to calculate this measure were readily available. This cost-burden measure was also discussed in Report 1 since the idea that premiums exceeding 2 percent of coverage are excessive was suggested in HFIAA 2014. The committee does not endorse this as a measure of cost burden. For further discussion, see Chapter 4 of this current report.

flood insurance premiums for reinsurance. Another is that the decision is for FEMA not to purchase reinsurance, but to continue to borrow from the federal treasury when necessary. This uncertainty by itself suggests that two different baselines are possible.

There are other future uncertainties independent of BW 2012 that can affect baseline conditions.[8] For instance, the baseline takeup rate for flood insurance policies will be influenced by many factors. For instance, the amount of marketing of insurance policies by FEMA, general economic conditions, the occurrence of storms, and so forth can all impact takeup

[8] The number of drivers of future conditions may be dictated by time horizon or nature of questions. To illustrate sea-level and climate change effects 30 years into the future is a different projection requirement than projecting private flood insurance policies in force in the next 5 years.

BOX 2-5
Illustrating the Challenge of Defining a Metric: Community Resiliency

> Resiliency has been defined as "the capacity of a system to absorb change and disturbances, and still retain its basic structure and function—its identity[a] (Walker and Salt, 2006).

A resilient community is one which has the capacity to "absorb change and disturbances," returning quickly to full function. One test of community resiliency is its ability to recover from a major flood. Another concern that may be expressed by policy makers is what impact BW 2012 would have on a community's ability to recover from a flood.

The disruptions most relevant to NFIP flood insurance are direct damages to property and its contents. Following a flood, property owners bear the responsibility for repair or replacement of damaged buildings. Residential structures may be damaged or destroyed, relocating population and disrupting community cohesion. In some cases, property owners may have the financial resources—either available funds or borrowing capacity—to move quickly to restore properties to pre-flood conditions. However, many if not most property owners are not in a position to finance major, unanticipated repairs, let alone complete reconstruction.

The other means of dealing with flood damage are the following:

- Abandon the property, either in full or in part.
- Use post-flood disaster assistance (in the form of grants or low-interest loans) and other funds as needed to make needed repairs or replacements.
- In the case of properties covered by flood insurance, use insurance proceeds and other funds as needed to make needed repairs or replacements.

The first option is, of course, the antithesis of resiliency. If this is the result for some number of properties throughout a community, then the structure and the function of the community are lost or, at best, seriously damaged.

Although some states can provide a limited amount of post-flood assistance, the major programs of this kind are operated by the federal government—principally FEMA, the Department of Housing and Urban Development (such as the community development block grant [CDBG] program), and the Small Busi-

rates. Further, there is increasing interest in the private sector becoming more involved in underwriting flood insurance. New technologies and a better understanding of flood risks may have increased that interest (GAO, 2014a). Other examples of different baseline conditions include projections of changes in population density in flood-prone areas, price and extent of private-sector flood insurance offerings, and effects of changes in flood risk related to climate change.

ness Administration (SBA). A 2012 paper (Kousky and Shabman, 2012) analyzes the aid households can expect to receive from these programs and find that it is much less than many may anticipate. Federal assistance is only available in the case of a federal disaster declaration, which does not occur for all floods. FEMA grants to individuals through the Individual Assistance program are also only authorized in a subset of declarations; GAO (2012) found that, for declarations issued between 2004 and 2011, only 45 percent authorized Individual Assistance. Furthermore, the amount of this assistance is quite limited—capped at a bit more than $30,000 per property (this number is indexed to inflation), and the average payout is only $4,000 (McCarthy, 2010). Low-interest loans from the SBA may be available, but these must be repaid, although that can help provide liquidity to homeowners. Individuals may receive grants through their state or local government funded by a CDBG, but that is highly uncertain. Local governments have enormous flexibility in how they use these funds and only in a few instances have they been used to make large grants to households simply for repair. Kousky and Shabman (2012) also noted federal disaster aid might not be disbursed for many months after the event.[a]

For any significant damage, it would appear that the property owner must bear the bulk of the financial responsibility. Clearly some may be unable to do so. Insurance can thus be resiliency enhancing in that it can make the funds needed for rebuilding available to disaster victims. In summary, reliance on disaster aid seems likely to produce only partial recovery and that only after some delay. For both reasons, some community resiliency is lost.

In a policy simulation, the best metric for representing community resilience may simply be the takeup rate (expressed as a percent of properties) of flood insurance. It is a metric that can be affected by a policy change and is measurable, at least in principle. And it has a logical connection to the basic concept to be represented. Communities with high takeup rates can be expected to be more resilient than those that rely on self-funding and government assistance. High takeup rates will be associated with not only more complete recovery of community structure and function, but also more timely recovery.

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[a] There are also several programs post-disaster to fund investments in hazard mitigation, such as the Hazard Mitigation Grant Program, the Increased Cost of Compliance coverage of the NFIP, and at times CDBGs. This discussion, however, was about funding simply repair, and not investments in mitigation.

The baseline can be defined on the assumption that fully implemented BW 2012 does not trigger behavioral responses by floodplain property owners and occupants. This may not be the most likely outcome through time, however. Most obviously, increasing premiums might change the number of policies in force. If this possibility is to be included in the baseline, then a prediction equation will be needed to relate policies in force to changes in the cost of premiums attributable to BW 2012 (see Box 2-6).

BOX 2-6
Premiums, Insurance Purchase, and Mitigation

The call for an affordability framework in HFIAA 2014 reflected a congressional interest in whether higher premiums might result in reduced purchase of flood insurance[a] and conversely whether a premium assistance program might maintain purchase by those who might drop coverage or encourage purchase by those who never had coverage before. BW 2012, as well as HFIAA 2014, reflected congressional intent that FEMA encourage property owners to implement mitigation actions, including but not limited to structure elevation that FEMA would credit toward premium reductions.

The cost of flood insurance is the premium paid when the policy is purchased. The benefit is the promise of compensation in the form of a claims payment, bounded by the chosen deductible and coverage amount. Each property owner must decide how much insurance coverage to purchase or maintain so that the perceived expected benefit justifies the cost. In many cases, the outcome of that decision is to purchase no insurance at all.

Many factors, other than premiums, affect the insurance purchase decision. Benefits are evaluated by property owners based on their estimates of the probability of flooding and the estimated loss should flooding occur. Those estimates may differ substantially from the FEMA-estimated probability and loss. Other factors affecting purchase may include

- expectations for disaster aid,
- income available to pay the premium in consideration of other expenses,
- mandatory purchase requirement, and
- risk attitudes.

These factors all need to be considered when trying to isolate the effect of premiums on the insurance purchase decision. Despite the interest in the effect of premiums on takeup, a review of the literature in Report 1, Chapter 4, concluded that any prediction of the effect of premium levels on the decision to buy insurance would be accompanied by substantial uncertainty. For this reason, the North Carolina report did not simulate changes in takeup rate or in mitigation adoption due to changes in premiums.

However, absent a reliable prediction model, an alternative is to have the baseline assume that BW 2012 will not affect policies in force and then recognize that possibility as part of a qualitative discussion of the analytical results. The choice of future baseline conditions is a judgment for the analysts and may play an important role in analyzing alternative policy options for addressing affordability issues.[9]

[9] Given that projections will be highly speculative, FEMA analysts may want to consider more than one baseline, with a "base baseline" being no change and one or more alternative baselines allowing for changes (e.g., in the takeup rate).

The literature reviewed suggests that premium price elasticity of demand for insurance—the sensitivity of the quantity demanded to changes in the price—is quite inelastic. This means that a 1 percent increase in price will bring about a reduction in policies in force of less than 1 percent, perhaps significantly less than one-half percent. This conclusion, however, cannot be made with confidence, so for the purposes of microsimulation, further review of the literature, or perhaps new empirical studies, may be needed on the decision processes.

There are additional complicating factors. For one, the actual price elasticity may differ from one location to another. For example, policyholders in coastal high-risk zones such as areas in the special flood hazard area that are subject to additional hazards due to storm induced wave action may be less sensitive to changes in premium levels, due to a greater sense of risk. Policyholders in multiunit buildings may be more sensitive, due to a lower perception of risk. In addition, some of the price changes that may be considered are larger than what has been observed in the past. In these cases, it is unclear whether the demand response is reasonably predictable using past data.

Now consider the effect of premium levels on the decision to implement mitigation. All mitigation measures present the same problem: how to justify a capital investment at the present time on the basis of insurance premium reductions expected in the future. This is a benefit-cost problem, although the property owner may not see it as such. A way to proceed is to identify any mitigation measures likely to be feasible for a particular structure, determine the upfront cost and any continuing maintenance cost for each identified measure, and then obtain an insurance premium quotation that may reflect a lower price due to the reduced expected flood losses from undertaking the mitigation measure.

If insurance purchase and adoption of mitigation is a matter of policy concern then it will be necessary for microsimulation to build behavioral response modules using assumed premium price elasticity estimates. The elasticity estimates used in microsimulation under these conditions would be based on best available information and would report the sensitivity of the simulation results to different elasticity assumptions.

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[a] Policies in force across the nation were 5,646,144 in 2011; 5,620,017 in 2012; 5,568,642 in 2013; and 5,350,887 in 2014. Data source available at http://www.fema.gov/total-policies-force-calendar-year (accessed on October 29, 2015).

Formulate Alternative Policy Options

Report 1 (Chapter 6) presented six design decisions (questions) and associated options for designing an assistance program within an affordability framework. These questions are reproduced in Figure 2-1 below. In addition, Report 1 (Chapter 7) described options for providing direct assistance to cost-burdened policyholders, as well as policy options that could reduce premiums for all policyholders.

Affordability policy options can be one or multiple combinations of direct assistance and other reforms (premium reductions) (Figure 2-1). If a

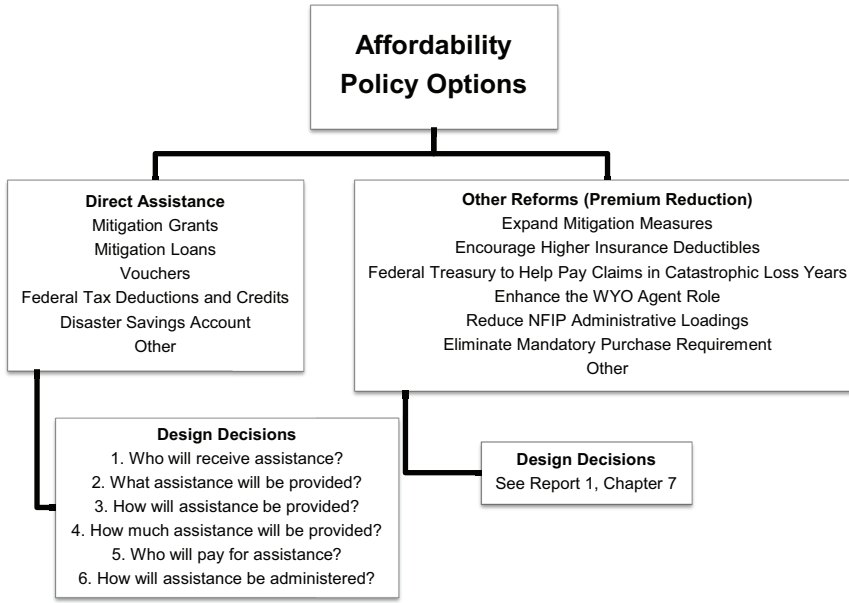

FIGURE 2-1 Affordability Policy Options
SOURCE: Adapted from NRC, 2015a (Report 1, Chapters 6 and 7).

direct assistance program is included, then answers to each of the six design decision questions must be provided to define the specific features of the assistance program. As one example, an alternative option might be limited to allowing flood insurance premiums to be included as a federal income tax deduction, based on specified conditions of the taxpayer. As another example, a cash assistance program (whether for premiums or mitigation) combined with NFIP risk-based premiums will need to specify conditions that can be used to define who is eligible and the amount of assistance received. If other policy reforms are to be included, then their provisions must be completely specified. For example, if the federal treasury is to pay all claims that exceed a specified level in a given year, then that level needs to be specified.

Numerous affordability policy options can be identified early in the evaluation process and then become more refined in their design as the analysis proceeds; additional options may be introduced at any time. Analysis may show that some options may be incompatible and cannot be included in an affordability policy option.

Conduct Simulations

Microsimulation as an analytical approach can predict how a given policy option might affect an evaluation metric relative to a baseline condition. Also recall that the modifier "micro" in microsimulation means that effects of an alternative policy option are first estimated at the level of the property owner and occupant if not the owner and then aggregated. If applied to an analysis of NFIP affordability policy options the database must include data for individual properties and their owners. The properties can be a sample that represents the larger population of interest up to and including every property in the population. It is understood that data may be sparse at first; that is, the information about the characteristics of properties and owners may be limited. As such, it might not be possible to answer some questions at all, while answers to some other questions are incomplete or otherwise limited.

The effect of data limitations is demonstrated by the experience of the North Carolina proof-of-concept analysis. In that work the question posed was, "How many policyholders will be cost burdened by higher rates?" For any individual property owner, the answer requires a definition of cost burden (see Report 1, Chapter 6). Only then is it possible to develop a description of whether a policyholder is faced with an unaffordable premium increase or not. In the North Carolina study, the available data used to define cost burden were values of the ratio of flood insurance premium to insurance coverage expressed as a percent, and values greater than 1 percent were defined as cost burdensome. This cost-burden measure was chosen because policyholder income and annual housing costs were not available; however, the committee does not recommend this as a measure of cost burden. Although the analysis was not able to use an income-referenced measure of cost burden, the effort to answer this question focuses attention on this most important data gap. One result was to stimulate discussion among the committee on use of assessed property values as a reference for measuring ability to pay higher premiums, in recognition that such data are available in all communities. This possibility is discussed in detail in Chapter 4. Options for filling data gaps are described in Chapter 3.

Generally, the North Carolina analysis had to predict metrics (Table 2-2) for the baseline and then predict the metrics with specified policy options in effect. An example can illustrate. Two of the questions addressed in the North Carolina report were, "How many policyholders will be cost burdened by higher rates?" and "What would be the cost to the federal treasury of a premium assistance program?" Analyzing these questions required first narrowing their focus to a particular subpopulation of policyholders. In this application, the focus was narrowed to policyholders who at the time BW 2012 first went into effect would lose their eligibility for a pre-FIRM sub-

sidized rate or grandfathered rate. This focus then meant that a descriptive tabulation was required to estimate how many policies were grandfathered and how may were paying pre-FIRM subsidized rates prior to BW 2012. In the North Carolina analysis pre-FIRM subsidized polices were identified in the NFIP database, but an algorithm had to be developed for tabulating which policies were grandfathered.

Then an "if-then" calculation was made for those affected policyholders. Each policyholder's coverage selections reported in the NFIP database, as well as property characteristics (flood zone, first-floor elevation), were data inputs to the appropriate NFIP rating tables. The result was an estimate of the NFIP risk-based premium for that property. Subtracting the estimated payment made prior to BW 2012[10] from the new premium estimate was the increased payment to the NFIP for each policyholder. Summing over all affected policies resulted in an estimate of the new premium revenues to the NFIP from BW 2012, specifically from these policyholders. However, which of the policyholders would be cost burdened by the higher rates? This required defining a measure of cost burden (see Chapter 4, section on The Ability to Pay Flood Insurance Premiums) and then tabulating the number of cost-burdened policyholders with BW 2012.

Next an affordability policy option had to be described. For ease of simulation and given available data that policy was to restore pre-FIRM subsidized rates and grandfathered rates to eligible policyholders; also, any forgone revenue to the NFIP from that restoration would be paid to the NFIP from the federal treasury. Eligibility was defined by two criteria: (1) having a PFS or grandfathered rate prior to BW 2012 and (2) being cost burdened by the NFIP risk-based rate under BW 2012. Based on the predicted NFIP risk-based rate (as the baseline) and the predicted rate paid prior to BW 2012 (the alternative policy option of restoring pre-FIRM subsidies and grandfathering for those eligible), estimates would need to be made of how many policyholders would receive assistance (that is, have their rate discounted) and how much revenue would be provided by the treasury to the NFIP.

Compare and Display Effects of Alternative Policy Options

The estimated effects of an alternative policy option (e.g., an affordability assistance program) are changes in the chosen outcome metrics relative

[10] Although the NFIP policy database included premiums paid, the estimate of pre–BW 2012 premiums based on North Carolina's own data and the value recorded in the NFIP database frequently disagreed, often substantially. So estimates based on North Carolina's own data were used for premiums both without and with BW 2012 in effect (see Chapter 3 for further discussion).

to the specified baseline. The North Carolina study identified, defined, and described a baseline with removal of pre-FIRM subsidized and grandfathered rates under BW 2012 and illustrative alternative affordability policy options (Table 2-3). The analysis was constrained by available data, time for completing the study, and models available to predict metrics that represent selected outcomes under the baseline and alternative policy options. The policy options described are a small subset of the numerous possibilities suggested previously in Figure 2-1.

The NCFMP databases and models were used to simulate the baseline and alternative policy options. Output results were displayed in tabular form to compare the alternative policy options with the baseline. Three examples of model output results are shown for illustrative purposes below.

EXAMPLE 1. How cost burdened are policyholders by their flood insurance premiums?

	Number and Percent of Policies			
Severity of Cost Burden	Baseline		Alternative Policy Option	
Not cost burdened				
Cost burdened				
Severely cost burdened				
Total				

EXAMPLE 2: Does NFIP pricing follow actuarial principles regarding net revenues and cross-subsidization?

	Baseline	Alternative Policy Option
NFIP net revenue		
Percent of revenues from cross subsidies		

EXAMPLE 3: How does an alternative policy option affect federal spending?

	Baseline	Alternative Policy Option
Annual payment to NFIP for forgone revenue		
Annual total payment to eligible policyholders for premium assistance		
Annual total payment to eligible policyholders for mitigation assistance		

TABLE 2-3 Illustrations of Baseline Condition and Alternative Policy Options

Baseline Condition	Immediate NFIP risk-based rates for selected policyholders	All policyholders who were paying pre-FIRM subsidized or grandfathered premiums will now pay NFIP risk-based premiums. The preferred risk policy and specific rate policy rates are unchanged. No change in the number of policies in force as a result of BW 2012 implementation. Cost burden was defined for illustrative purposes as when premiums exceeded 1 percent of flood insurance coverage. The committee is not endorsing this as a measure of cost burden.
Alternative Policy Option: Premium assistance so that policyholders pay what was paid before BW 2012	Provide premium assistance by reducing premiums for those policyholders who meet two eligibility criteria: 1. NFIP risk-based premium will exceed 1 percent of flood insurance coverage. 2. Had received pre-FIRM subsidized or grandfathered rates before.	For policyholders meeting the two eligibility criteria, their premiums are restored to the amounts paid prior to BW 2012 (that is, the pre-FIRM subsidized or grandfathered amounts).
Alternative Policy Option: Premium assistance so that policyholders pay no more than 1 percent of coverage	Provide premium assistance by reducing premiums for those policyholders who meet two eligibility criteria: 1. NFIP risk-based premium will exceed 1 percent of flood insurance coverage. 2. Had received pre-FIRM subsidized or grandfathered rates before.	For policyholders meeting the two eligibility criteria, premiums are capped to 1 percent of total flood insurance coverage.
Alternative Policy Option: Premium or mitigation assistance	Provide premium assistance ***or*** mitigation assistance grant to those policyholders who meet two eligibility criteria: 1. NFIP risk-based premium will exceed 1 percent of flood insurance coverage. 2. Had received pre-FIRM subsidized or grandfathered rates before.	Premium assistance is a payment equal to the difference between the NFIP risk-based rate and the previous pre-FIRM subsidized or grandfathered rate if a policyholder is eligible. Mitigation assistance grant is amount required to elevate property to base flood elevation plus 2 feet for those property owners who meet the eligibility criteria.

SUMMARY

FEMA was directed by Congress to conduct a study on how BW 2012 would affect the affordability of flood insurance premiums. Currently FEMA does not have a modeling approach in place that can be used to answer the kinds of questions that follow from BW 2012. The most promising way forward is to initiate a process for building modeling capacity over time.

Finding 2.1. FEMA's capability to evaluate affordability policy options is very limited but can be substantially advanced by embracing a microsimulation modeling approach and building the model incrementally through time. This would begin with conceptual microsimulation model design and the writing of computational algorithms for the self-contained modules, as necessary data are identified and data gaps filled.

Finding 2.2. Conducting the initial affordability analysis and building longer-term capacity following a six-element or similarly structured planning and evaluation process can focus the analysis activities on key questions, aid in the identification of the most policy-relevant evaluation outcomes, ensure that policy options and outcome metrics are described in ways that are amenable to empirical representation in a microsimulation model, identify modeling and data needs as well as gaps, and, as a result, expedite the execution and enhance the quality of the initial policy analysis and continuing development of analytical capabilities.

3

Data for Analyses of National Flood Insurance Program Policy Options

Congress, through the Biggert-Waters Flood Insurance Reform Act 2012 (BW 2012) and Homeowner Flood Insurance Affordability Act 2014 (HFIAA 2014), requested the Federal Emergency Management Agency (FEMA) to undertake a suite of complicated and technical tasks to propose a draft affordability framework for the National Flood Insurance Program (NFIP). The analytical calculations needed to do such analysis were described in Chapter 2. Making these calculations requires the construction of one or more microlevel databases with the necessary data for analysis of representative properties in the nation's floodplains. Ideally, the database(s) will include data on property characteristics, the socioeconomic characteristics of the property owner and occupant (if different from the owner), and the NFIP policy (if there is a policy in force on that property).

At present, FEMA has access to the NFIP policy database that includes some of these data and to flood insurance rate maps (FIRMs) that in some places could be used to characterize the likelihood of floods that reach different stages in different areas of the floodplain. To evaluate affordability policy options, however, additional data on variables not in the NFIP database and existing FIRMs will be needed.[1] This chapter describes the data

[1] The content of this chapter is consistent with findings of several other reports that document the need for additional data pertinent to the NFIP (i.e., GAO, 2014a; King, 2013; PwC, 1999). For example, GAO (2014a) could not calculate forgone premiums—the difference between subsidized policies and full-risk premium policies—as there was a lack of property elevation data for pre-FIRM subsided policyholders.

in the NFIP policy database and the data that can be derived from FIRMs. With this as background, data gaps needed for conducting the kinds of analyses described in Chapter 2 are identified, and means for filling such gaps discussed.

THE NFIP POLICY DATABASE

FEMA's NFIP policy database includes about 4.5 million records and 76 data fields. The database was created for tracking NFIP policies insured by the Federal Insurance and Mitigation Administration (FIMA) that resides within FEMA.[2] The flood insurance policies in the database include those written by direct servicing agents, the Write-Your-Own (WYO) Program agents, and private insurance agents in companies not associated with the WYO program. In May 1998, the NFIP created a manual that insurance companies must abide by when collecting and submitting policyholder information. All of the policy information submitted is compiled into the NFIP policy database, which is updated on a monthly basis (NFIP, 2013).

Depending on the type of structure being insured, the NFIP uses three different forms for flood insurance policy applications:

1. Dwelling forms are used for homeowners, residential renters, or owners of residential buildings that contain one to four units.
2. General property forms are used for owners of residential buildings with five or more units, as well as for owners or lessees of nonresidential buildings or units.
3. Lastly, residential condo building association forms are provided to residential condo associations on behalf of the association and their unit owners (FEMA, 2014).

The review of the NFIP policy database for this report was based on a snapshot of the NFIP policy data from October 2013.[3] The October 2013 NFIP policy database includes the following information and attributes as categorized below.

Policies. The NFIP policy database includes general identifying information about the policyholder, including name and address. Since FEMA

[2] The NFIP maintains a claims database that was not part of this review.

[3] The assessment of the NFIP data reported in this chapter was complicated by difficulties in accessing and understanding the NFIP database. For example, neither a data dictionary nor metadata was available for the database. By following ISO 8000 and 9001 standards, as well as Federal Geographic Data Committee metadata standards, the NFIP could adopt a well-recognized process of data management that will help users access and understand the content of the NFIP database.

tracks policies by the individual, rather than by the property, unique policy numbers are assigned to each policyholder and property holder. When a policyholder moves, a new policy number is assigned. Some aspects of the policy are protected by FEMA under privacy concerns, such as names and addresses, and are not available to the public. Other general policy information within the NFIP policy database includes

- policy status (active, canceled, etc.);
- number of policy terms (number of years the policy is effective: 1 year, 3 years, etc.);
- whether the policy was required for disaster assistance, and if so, by which agency;
- company code of the WYO company responsible for the policy (where applicable);
- whether the policy is for a single-family or multifamily property; and
- whether it is for a residential or nonresidential property.

Location. Several attributes related to the spatial location of the insured property can be found in the NFIP policy database, including the latitude and longitude coordinates of the property; the property address, city, state, and zip code; the FEMA region; and which Census block (and block group) the property falls within. Information on how accurate the horizontal geocoding is for the property is also provided so the user knows how well the policy is located. The NFIP application does not contain the latitude and longitude coordinates of the property. This information is generated by FEMA using outside firms to geocode the property address. In addition, FEMA includes the attributes from the FIRMs as part of the policy database. The NFIP community and county that the insured structure is located within, as well as the map panel number and flood zone, as obtained from the FIRMs, are also provided.

Chosen Coverage. Insurance deductible and coverage amounts for both the property and the contents are included within the policy database, as are premiums. Policy endorsement dates, original effective dates (for rollover policies), current effective dates, and expiration dates are also provided.

Premiums/Policy Type. Several attributes within the NFIP policy database are utilized for the insurance premium calculations. Some of these elements include

- whether it is a new policy or a renewed policy;
- what flood zone was used for rating the policy;

- if the policy has a V zone (which are areas within the special flood hazard area (SFHA) with additional hazards associated with storm-induced waves) risk-factor rating, where a qualified professional assesses the building's location, its support system, and its ability to withstand wind and wave action. If the professional certifies that the property has a lower risk of flood damage based on these three factors, then the property becomes eligible for a premium discount;
- whether it is a pre- or post-FIRM property;
- type of residence;
- whether the policy falls under any BW 2012 categories and, if so, which BW 2012 category it would fall under. Some examples of the BW 2012 categories include single-family nonprincipal residences, businesses, severe repetitive loss pre-FIRM subsidized properties, and multifamily residences;
- whether the property is in a Community Rating System (CRS) community, and if so, which CRS class that provides premium discounts to all homeowners in the community ranging from 5 percent (Class 9) to 45 percent (Class 1);
- the policy's NFIP community program type (regular or emergency);
- the location of the contents within the structure; and
- any obstruction types/categories associated with the structure. Some of the factors used to establish the obstruction categories include the size of the structure (less than or greater than 300 square feet), whether the structure has breakaway walls, if the building has an enclosure or crawl space with proper openings, whether there is machinery or equipment and is it above or below the base flood elevation, whether there is an elevator and is it above or below the base flood elevation, and whether the building is elevated.

Building Characteristics. The policy dataset provides several building attributes that can be used to review and assess flood risk at the structure level. Some of these characteristics include when the structure was built, whether the property is in the course of construction, the number of units within the property, the number of floors in the building, the type of basement or enclosure it has (if any), and whether the building is elevated and/or flood proofed.

Elevation Data. The following fields are provided in the NFIP policy database, but the information within them is not fully populated for all policies:

- Base flood elevation (BFE) from the FIRMs
- Whether there is an elevation certificate for the property and, if so, what the diagram number is

- Elevation of the lowest floor
- Elevation difference between the BFE and the lowest floor
- Lowest adjacent grade

FEMA utilizes many of the policy attributes listed above, in addition to building characteristics and elevation information discussed below, to establish a risk-rating method for each elevation-rated policy. Policies issued for properties outside the SFHA are not risk rated, as is the case for pre-FIRM subsidized policies that are now being phased out. For properties outside the SFHA, elevation data will be missing.

Miscellaneous Attributes. There are a few other fields included within the NFIP policy database that do not necessarily fit within the categories mentioned above, but that may still be of value for an affordability analysis. These include

- whether the property is state owned,
- the federal policy fee,
- the community probation surcharge amount, and
- the insurance to value indicator.

Most of the fields included in the NFIP policy database are well populated. The October 2013 policy database had a 95 percent completion rate or better in regard to general information about the policy and policyholder, the geographic location of the insured structures, data from the community's FEMA FIRMs, the insurance deductible and coverage amounts for each policy, the policy premiums and risk ratings, and insured building characteristics under each policy. Although this information is needed for constructing a database as inputs for evaluating the affordability of insurance policies, there were some limitations related to the completeness of the policy data as well. Most importantly, about 70 percent of the policy records lack information about structure elevation relative to the BFE.

For assessing current risk, it is necessary to know the current flood zone for the property. The reported flood zone in the database, however, is the one that was used for the initial policy risk rating. To identify the actual current NFIP flood zone that the structure lays within, a geospatial analysis would need to be performed whereby all of the NFIP policies are intersected with FEMA's National Flood Hazard Layer (NFHL). This can be a time-consuming process at the national level that can take a geographic information system (GIS) specialist 4 to 6 weeks to complete, but it would provide accurate location information for assessing actual policy risk ratings and any premium adjustments that may be needed as a result. Appendix H

reports the data fields found within the October 2013 version of the NFIP policy database.

Finding 3.1. Simulating premium increases if NFIP risk-based rates are charged requires having elevation data for each insured property. Such data are now being requested for properties that were previously paying pre-FIRM subsidized rates. Because flood insurance premiums for policies on properties outside the SFHA are not elevation rated, elevation data for those properties are missing and are not currently being collected.

FLOOD INSURANCE RATE MAPS

FEMA has completed an ambitious program to provide the nation with coverage of digital flood insurance rate maps (DFIRMs) for approximately 1 million of the 3.2 million stream miles in the nation; the 1 million miles are located where the majority of the nation's population lives. The first phase of this program, called Flood Map Modernization, operated from 2003 to 2008, and a subsequent phase, called Risk Mapping Assessment and Planning (Risk MAP), is now in operation (FEMA, 2009a, 2009b). Currently, following instructions from BW 2012, a technical mapping advisory council is preparing a report on several mapping topics including how to improve, in a cost-effective manner, (a) accuracy, general quality, ease of use, and distribution and dissemination of FIRMs and risk data; and (b) performance metrics and milestones required to effectively and efficiently map flood risk areas in the United States.

Lenders use FIRMS to determine whether flood insurance is required by property owners. Private insurance agents use the FIRM to help quote a policy premium. This determination is made on the basis of a horizontal criterion: Does the building lie within or outside the mapped SFHA? The current FIRMs, by showing the boundary of the SFHA, adequately support this flood insurance purchase requirement determination.[4] For quoting a premium, an essential component of FIRMs is the BFE, which is the water surface elevation that would result from a flood having a 1 percent chance of being equaled or exceeded in any year at the mapped location.[5] The BFE is a vertical, rather than a horizontal, criterion used in flood insurance purchase requirement determinations. The NFIP risk-based premium

[4] If a property owner whose building is classified as being within the floodplain wishes to protest that determination, a procedure is available, for both the owner and the NFIP, to process a Letter of Map Amendment.

[5] In addition, local communities regulating land development are expected by the NFIP to require the first-floor elevation of buildings to be at or above the base flood elevation.

(elevation-rated premium) is based on the difference between the lowest habitable floor elevation of the property and the BFE for the zone within the SFHA, as well as a limited number of other property characteristics. Base flood elevations are shown on floodplain maps that have been prepared with high-quality land surface elevation information and detailed flood modeling studies.

The implementation of FEMA's Risk MAP program in 2009 began an effort to provide communities with flood information and tools to enhance mitigation planning, providing more information than the boundary of the SFHA and the BFE. Risk MAP continued the focus on technological advancements that included elevation data acquisition and more accurate mapping of areas impacted by levees and coastal flood hazards (FEMA, 2009a). Of note for affordability analysis is the inclusion of flood risk assessment products (also known as nonregulatory products) with the maps. Nonregulatory products were an additional feature of the mapping process and FEMA provides a package of nonregulatory products under Risk MAP. Examples of such products include changes since the last FIRM (if digital flood data are available from the previous study), water surface elevation grids and flood depth grids, percent annual chance grids and percent 30-year chance grids (the percent chance that an area will flood over the course of a typical 30-year mortgage), flood risk assessments, and areas of mitigation interest. One of the benefits of these products is that many of these studies include elevation data from the 10 percent, 4 percent, and 2 percent annual chance flood events in addition to the 1 percent (SFHA or 100-year floodplain) and 0.2 percent annual chance flood events (500-year floodplain).

Finding 3.2. In some areas of the nation, all stream miles have not been mapped and in places that have been mapped many FIRMs do not yet include the BFE. Furthermore, DFIRMs do not describe the full range of flood stages and associated probabilities, unless their content has been supplemented by local community investments in providing additional data and analysis.

OTHER DATA SOURCES

The questions posed to FEMA will require data for policyholders and the insured properties, as well as uninsured properties and their owners, which cannot be found in the NFIP policy database or derived from the DFIRMs. Particularly important data gaps include the absence of first-floor elevation data for many policies and the absence of any data on uninsured properties. Furthermore, even if all of the data in the NFIP policy database were complete and accurate, the database could not be used to simulate affordability assistance programs that are means tested because the data-

base does not contain income, wealth, or housing cost data. This section discusses other data sources that may be available to FEMA to address these and other data needs.

Decennial Census/American Community Survey Information

The decennial census of population and the continuing American Community Survey (ACS) are sources of information that may help FEMA answer some kinds of policy questions. The census provides complete population counts for the nation and subnational geographic areas down to census tracts (small, relatively stable geographic areas of about 2,500 to 8,000 people), block groups (statistical divisions of census tracts of about 600 to 3,000 people), and individual blocks once every 10 years. The data collected in the census are limited to basic demographic information (age, gender, race/ethnicity, and household relationship) and housing tenure (owner or renter). The data provide the basis for population estimates that are updated each year for states, counties, cities, and towns. These estimates can help FEMA identify population growth in flood-prone areas in a general way.

More helpful to FEMA is likely to be the information provided each year from the ACS, which, beginning in 2005, has collected detailed social and economic characteristics across the nation from a large sample of households. The ACS is conducted monthly, and data products are released every year for small areas down to census tracts and block groups. The content of the ACS questionnaire is roughly the same as what used to be in the once-a-decade decennial census "long-form" sample. There are questions on education, place of birth, citizenship, household relationship, income, employment, housing costs (mortgage/rent, utilities), housing characteristics (number of rooms, number of units in the structure, when the house was built, etc.), and other topics (NRC, 2007, 2015a). See Appendix F for a table of currently available ACS information for census tracts and block groups of potential relevance for FEMA.[6]

All data for census tracts and block groups released each fall are summarized over the preceding 5 calendar years (60 months); there are no 1-year (12-month) products available as there are for larger geographic areas (no data are available at all for blocks from the ACS). The latest census tract and block group data available are for 2009-2013, which covers the Great Recession and some economic recovery. The next round of data

[6] Public-use microdata samples (PUMS) from the ACS, which would allow FEMA to specify additional tabulations, are not useful for FEMA's purposes because no area is identified in the PUMS with fewer than 100,000 people.

for tracts and block groups, for 2010-2014, will be available at the end of 2015.

Although the ACS has a large sample (about 2.3 million responding households each year), even cumulated over 5 years, the ACS sample is only about two-thirds of the census long-form sample. This means that variability due to sampling error is higher than in the long-form sample for small geographic areas, and sampling variability in the long-form sample is itself high for very small areas (see NRC, 2007, Tables 2.7 and 2.8). Moreover, the need to cumulate over 5 years creates challenges when interpreting estimates and, especially, tracking changes over time. The ACS also has different residence rules from the census—the ACS asks people to indicate where they have been living in the past 2 months; the census asks people for their "usual" residence. For areas with seasonal populations, such as beach or lake communities, the ACS estimates may represent the "usual" (year-round) population if the "season" is short, or a combination of year-round and seasonal residents if the "season" is more than 2 months (as is likely to be the case, for example, for "snowbirds" moving between northern states and Florida, Arizona, etc.).

Even with high sampling variability and the issues with 5-year accumulations, the ACS provides a low-cost way for FEMA to overlay characteristics of interest for households in small areas (e.g., home ownership, median rent and mortgage amounts, median house value, median income, and age of housing stock) on maps of current and projected future flood-prone areas. FEMA could also reimburse the Census Bureau to prepare special tabulations by reaggregating the underlying ACS data to conform to geographic areas defined by FEMA to match floodplain boundaries. Such special tabulations could provide a clearer picture of areas in which there may be households at risk of floods and of inability to afford flood insurance premiums. Such areas could not be smaller in population size than block groups, which are the smallest areas currently released from the ACS, but the specially defined areas could have more relevant boundaries for analyzing flood risk and insurance affordability.

Published ACS data represent the aggregate of household characteristics in a block group, census tract, town, township, village, or city (or special tabulation area) and are not at the level of the individual policyholder. Consequently, care must be taken when using ACS small-area data in policy analysis of the likely effects of alternative flood insurance program provisions. For example, median household income could be the same in an area of homogeneous incomes and in an area with both very-high-income and very-low-income households, so that it would not be appropriate to impute the median value to all households without additional information. A more telling indicator of the distribution of income is to examine ratios of household income to the poverty level, such as the percentage of house-

holds with income at or below the poverty level and with income at more than twice the poverty level. Using the poverty level also takes account of the fact that households differ in size and composition and hence in income needs. The ACS currently provides ratios of household income to poverty level for census tracts but not block groups, and might be able to provide them for FEMA-defined flood-prone areas.[7]

Possible uses of ACS data for flood insurance program policy analysis could include the following:

- In small areas containing large numbers of current policyholders, ACS data for those areas could help indicate the likely affordability of premiums for the remaining households by using a combination of what is known about the policyholders (although currently very little information is available on policyholders) and all residents in a model to predict characteristics of interest for nonpolicyholders.
- In small areas that have no or small numbers of current policyholders but are in areas that are likely to face increased flood risk, ACS data could help FEMA identify areas with residents who may be at high risk of not being able to afford flood insurance premiums. FEMA could then decide to invest resources in those areas for additional targeted information from surveys, administrative records, and commercial sources to support an affordability analysis.

Given that many small areas are likely to have a mix of policyholders and nonpolicyholders, the use of ACS data for flood insurance program policy analysis is limited due to this heterogeneity, unless and until FEMA obtains additional data on policyholders for modeling purposes.

Federal Agency Administrative Records

It could be possible for FEMA to make arrangements to obtain information on household income and other characteristics for policyholders and other owners of at-risk properties from another federal agency. Access to federal administrative information would take time to arrange but, once established, could provide an inexpensive timely flow of key information that is regularly updated. For example, adjusted gross income could be

[7] For such areas, tables could display, for example, the percentage of families below 100 percent of poverty, the percentage between 100 and 200 percent of poverty, the percentage between 200 and 300 percent of poverty, the percentage between 300 and 400 percent of poverty, and the percentage above 400 percent of poverty. Of course, even in flood-prone areas, probably not all and maybe not even a high percentage of families with incomes that are low relative to the poverty level or other families will face premiums that are high relative to their income.

available from the Internal Revenue Service (IRS) or covered earnings and Social Security benefits from the Social Security Administration (SSA). Such access would require justification of a federal purpose that would accord with IRS or SSA regulations about allowable access, and it would also likely require that FEMA use the data and conduct its policy modeling under the terms of a memorandum of understanding in a secure environment, similar to that of a Federal Statistical Research Data Center (RDC),[8] to protect the confidentiality of the information.

Commercial Sources

Several commercial enterprises now collect data at the individual property level and perform their own internal analyses to predict home prices using GIS and related statistical modeling software. Some of these companies provide analytical services to the NFIP and also serve as data providers. Making arrangements to obtain information on, say, building elevation from remote sensing technologies and GIS or property values from local property records or realty sites would require a sustained effort, but could have substantial benefits for FEMA. Once experience is gained with such data sources, they could provide an inexpensive way of regularly updating key characteristics for at-risk properties. If these commercial entities have data that FEMA can use in a microsimulation they could sell such data to FEMA, as an alternative to expecting FEMA to gather new data. As one other example, there are private firms that maintain databases on mortgage balances at the individual property level. These data would be used to establish whether the property owner faces a mandatory flood insurance purchase requirement. However, getting access to the data which are proprietary can be expensive or maybe even not possible.

Local Tax Assessment Records and Other Related Sources

Most tax assessor offices maintain information needed for estimating and collecting property taxes. Of potential interest to an affordability study, this includes an assessment of the property's value, usually an estimate of the improved value (just the structures), as well as the land value. The extent to which such data are well organized, digitized, and easily made available to the public will vary among communities.

[8] An RDC is a location where a user (with appropriate clearance) can have access to restricted-use data (e.g., microdata) that would not otherwise be accessible. Analyses would be performed using the center's computer, and results would still be subject to all of an agency's disclosure rules. The Census Bureau originally established a network of RDCs around the country; these RDCs now house data from other agencies as well. Available at http://www.census.gov/about/adrm/fsrdc/about/available_data.html (accessed on October 7, 2015).

Municipalities will generally make assessors' data available (either for free or for a fee), although for most this will require contacting the office and making a formal request. While online tools to look up assessors' information are increasingly common, most communities do not simply provide their entire database for download just on their website. There is also substantial variation in whether communities maintain historical data on past sales, or only the current assessment. Furthermore, assessment practices can vary and some communities will maintain both the appraised value and the assessed value (when these differ), but others may only provide the assessed value, which may require calculations to convert back to the appraised value.

U.S Army Corps of Engineers

Many coastal and riverine areas of the United States have recently received new FIRMs or have new flood studies planned under the Risk MAP program or both, but not all of these FIRMs will include information of flood likelihoods and stages needed for the estimation of damage claims. There are other sources for securing such information. The U.S. Army Corps of Engineers (USACE) has multiple flood risk assessment tools available from its Hydrologic Engineering Center (HEC) that are used by engineers worldwide. HEC-HMS (Hydrologic Modeling System), which is a computer modeling software package, computes design flood hydrographs for specified return periods, such as 10-year or 100-year floods. HEC-RAS (River Analysis System) takes the highest discharge from the design flood hydrograph and calculates the corresponding flood water surface elevation above geodetic datum, using a map of land surface terrain and channel morphology often derived from light detection and ranging (LiDAR) data.

The USACE also has made available depth-damage curves for estimating property damage from flood events. Such curves give estimates of damages to a structure or its contents as a percent of its value based on the depth of water at the site. These are used for USACE flood damage reduction studies, but are publicly available for other uses as well. The most up-to-date curves available are generic, nationwide functions for residential structures with basements based on damage estimates from major flood events in the United States between 1996 and 2001.[9]

Hazus

Hazus-MH is a national, GIS-based software model developed for FEMA by the National Institute of Building Sciences. The objective of

[9] See http://planning.usace.army.mil/toolbox/library/EGMs/egm04-01.pdf.

Hazus is to provide an analytical platform for estimating the effects of natural disasters in a standardized way across the nation for use by public officials in planning and evaluating mitigation measures. It is designed to estimate damages from multiple types of hazards. In the flood model, Hazus couples a flood hazard analysis, which estimates the depth of flooding in the user-defined study area, with an estimate of economic damages from the flood. Hazus has also been used in academic studies (e.g., Dierauer et al., 2012; Kousky and Walls, 2014).

Hazus includes likelihoods of different flood depths for use in estimating flood hazard as well as depth-damage curves that can be used to estimate damages for different kinds of structures. The hazard component of Hazus can be used to fill in hazard information that may be missing from FIRMs for particular locations. Hazus uses depth-damage curves to relate depth of flooding to building and contents damages for each representative property. Hazus has many such curves in its library, which varies by property type (e.g., single-family residential, mobile home, and light industrial). Damage curves may also vary by characteristics of the structure. For example, for single-family properties these are year built, number of stories, and type of basement. These curves can be applied to individual structures. Hazus does not, however, have data on individual structures in its database. Instead, the properties in Hazus are what is reported from the U.S. Census of Population and Housing at the census block level, while nonresidential data come from Dun & Bradstret.[10] Hazus assumes the building stock is evenly distributed throughout a census block. This makes the database ill suited for microsimulaton. Therefore, only the hazard and damage procedures can be used in microsimulation modeling.

LiDAR

Building elevation data are often missing from the NFIP policy database and information available on building characteristics for properties that do not have an NFIP policy can only be acquired from other sources. LiDAR, which is a remote sensing detection system using light from a laser to measure distance, can be used to obtain ground elevations and other property data. One application of this technology uses lasers mounted on a fixed-wing airplane along with other instruments to determine the elevation of the earth surface. LiDAR has become the industry standard for obtaining accurate ground elevations efficiently. For example, in the early 2000s North Carolina acquired statewide, high-resolution LiDAR-derived topography and imagery. Table 3-1 shows the different accuracy levels and the monetary cost depending on how much LiDAR is obtained. In general,

[10] Dun & Bradstret is an American public company.

TABLE 3-1 Cost of LiDAR for Various Levels of Accuracy

Quality Level	Point Density	Nominal Point Spacing	Root Mean Square Error of Vertical Accuracy (RMSEz)	$ per square mile (mi^2) for 500-1000 mi^2	$ per mi^2 for 1000-5000 mi^2	$ per mi^2 for >5000 mi^2
	Units are points per m^2	Units are meters	Units are centimeters			
QL1 LiDAR	8	0.35	9.2	$602.50	$497.00	$453.25
QL2 LiDAR (USGS base specification)	2	0.7	9.25	$374.50	$310.75	$277.00
QL3 LiDAR	0.25-1	1-2	18.5	$291.50	$238.00	$209.25

NOTE: USGS, U.S. Geological Survey.
SOURCE: http://nationalmap.gov/3DEP/neea.html (accessed on October 7, 2015).

the minimum LiDAR order is 500 square miles, but significant savings can result if acquisition areas are greater than 5,000 square miles. For flood insurance study–related information, QL2 is the quality standard that is typically used.

LiDAR-based structure elevations can be used along with the BFE to determine the risk the structure has in relation to flooding. LiDAR technology has become one of the basic building blocks to determine ground surface elevations.

FILLING DATA GAPS

Gaps in the NFIP policy database and from DFIRMs are (a) elevation data for policies that are not elevation rated, needed to estimate future premiums, claims, and NFIP revenues; and (b) policyholder socioeconomic characteristics, needed for establishing cost burden and simulating eligibility, benefits, and costs of means tested assistance programs. There are no data—including the data in (a) and (b)—for properties, property owners, and occupants that are located in at-risk areas but are not covered by NFIP policies. These data may be needed for evaluation of policy options that might expand takeup.

These, as well as other less significant data gaps, might be filled using some of the other data sources described above. However, if other data sources are not sufficient then the approaches described in this section may

be needed. It is likely that a combination of the strategies will be needed not only for constructing an initial database, but also for creating future versions of the database.

Proxy Variables

A proxy means using one measure to stand in for another, when one measure is readily available and the other is not. For example, ground elevation at a property might be known from a DFIRM. A local tax assessment database, or a LiDAR report, might include the style of the building or the presence of a basement for that structure. This information about the property might allow for adding height to ground elevation and using that as a proxy for the elevation of the first habitable floor.

As another example, BW 2012 called for an affordability study to focus on "individuals who cannot afford" to pay NFIP risk-based rates. Policy makers may prefer to use household income as the measure of ability to pay. However, such a measure for the policyholder may not be available, but data on assessed property value may be.

Although a proxy variable might be used when the originally intended variable is very difficult and expensive to obtain, the two variables might be weakly correlated, suggesting that the proxy variable is measuring something substantially different from what had been intended. Analysts will be expected to explain the reasons for the use of proxy variables and any cautions about how results of the analysis should be interpreted by policymakers.

Sample Survey

The FEMA website states that the agency only collects the minimum amount of information necessary to administer the NFIP. Compliance with the requirements of BW 2012 and HFIAA 2014 and the need to evaluate NFIP policy option alternatives over time provide a reason for FEMA to collect information beyond what is currently collected.

FEMA could commission a spatial sample of homeowner/at-risk properties selected from the NFIP policy database. Particular data needs are elevation data for non-elevation-rated properties (may have to pay for the elevation certificate) and homeowner and occupant characteristics. For those selected, a survey might be administered to obtain such data. Alternatively, for those selected the needed data might be obtained through changes to the insurance application form (e.g., a supplementary form). In all cases, the survey results would be confidential and would not be entered into the NFIP database. Of course, this only will get information from current policyholders. To obtain data for properties that are not covered,

an additional spatial sample might be drawn for addresses in the nation's floodplains, with data collected by surveying the owners/residents at the selected addresses.[11]

A survey has the advantage that it can be professionally designed to obtain the desired information on a consistent basis. A drawback of a survey is its monetary cost. Depending on the interviewing mode (and personal interviews could be desirable for a FEMA survey because of the ability to capture information by observation) and the extent of follow-up needed to bring response rates up to acceptable levels, the cost of a completed survey case could be at least $200 to $300 per interview. Survey response rates have been falling for several decades in the United States and other countries; indeed, public opinion polls conducted by telephone may typically only obtain a 10 percent response. U.S. Office of Management and Budget guidelines require federal surveys to plan sufficient nonresponse follow-up to obtain an 80 percent response rate or, if this rate is viewed as unattainable, to plan for a study of a sample of nonrespondents to permit estimation of any nonresponse biases and their effects on key estimates. In the case of a FEMA survey, the information on current NFIP policies could help in modeling nonresponse adjustments for that portion of the sample, but it could not help for the portion comprising at-risk properties without flood insurance coverage.

How many completed survey cases are needed for a FEMA survey will be a function of the extent of disaggregation of microsimulation model results that is desired (greater disaggregation requires a larger sample to attain adequate precision of estimates) and the budget the agency can allocate to the effort. Arguably, FEMA can justify a one-time investment in a sample survey—even an expensive one—as providing the most accurate basis for an NFIP policy options microsimulation model. But the need for policy modeling is continuing and would not be used only one time. Flood risk will change for currently covered properties, other currently at-risk properties, and properties that at present are minimal risk. Finally, even with a large well-executed survey, there will be missing items for some

[11] Spatial sampling involves selecting a limited number of locations (a sample) in geographic space for faithfully measuring phenomena that are subject to "dependency" and "heterogeneity." Dependency refers to the phenomenon that observations at neighboring locations are more similar to one another than are observations at locations farther apart. Dependency suggests that a value at one location can predict the value at another location. Spatial heterogeneity refers to attributes of geographical variation. Spatial heterogeneity suggests that dependencies can change across space (also referred to as "nonstationary") and, therefore, it may be unwise to trust an observed degree of dependency beyond a region that may be small. Spatial sampling techniques are more efficient than conventional sampling when surveying spatially distributed targets, where spatial autocorrelation and heterogeneity are prevalent (Banerjee et al., 2004).

properties. Surveys typically impute such missing values from the information provided by other respondents.

Finding 3.3. Information available from the NFIP policy database and from FIRMs are missing data critical to a comprehensive analysis of policy options. Numerous other sources of information, including new survey data collection, could be used to conduct microsimulation policy analyses. Although the data for a national affordability study initially will be limited, numerous opportunities for database improvement for answering NFIP policy questions can be secured as budget resources permit.

SUMMARY

A task of the committee was to discuss data needs and data gaps—the completeness and quality of data needed for policy analysis. Data needed to evaluate alternative options include data about flood insurance policies, property characteristics, and property owner/resident socioeconomic characteristics. At present, FEMA has ready access to two internal databases: the NFIP policy database and FIRMs. To evaluate affordability policy options, additional data on variables not presently available or that might replace or supplement the FEMA data are needed.

A particularly important gap in the data for many policies is the absence of first-floor elevation data that are necessary for estimating the damage to the structure from floods of different magnitudes. Although some of those data are now being collected for properties inside the SFHA, such data are not available and are not being collected for properties outside the SFHA. Also, even if all of the data in the NFIP policy database were complete and accurate, the database cannot be used to simulate affordability assistance programs that are means tested because the database does not contain income, wealth, or housing cost data. Furthermore, the NFIP database does not contain information for nonpolicyholders located in flood-prone areas and cannot be used to analyze whether an alternative policy option that would reduce premiums or provide assistance might promote takeup among such households. These and other data gaps need to be filled, and the report discusses approaches to filling those data gaps.

Finding 3.1. Simulating premium increases if NFIP risk-based rates are charged requires having elevation data for each insured property. Such data are now being requested for properties that were previously paying pre-FIRM subsidized rates. Because flood insurance premiums for policies on properties outside the SFHA are not elevation rated,

elevation data for those properties are missing and are not currently being collected.

Finding 3.2. In some areas of the country, all stream miles have not been mapped and in places that have been mapped many FIRMs do not yet include the BFE. Furthermore, DFIRMs do not describe the full range of flood stages and associated probabilities, unless their content has been supplemented by local community investments in providing additional data and analysis.

Finding 3.3. Information available from the NFIP policy database and from FIRMs are missing data critical to a comprehensive analysis of policy options. Numerous other sources of information, including new survey data collection, could be used to conduct microsimulation policy analyses. Although the data for a national affordability study initially will be limited, numerous opportunities for database improvement for answering NFIP policy questions can be secured as budget resources permit.

4

Analytical Next Steps and Further Findings for Affordability Policy Options

This is the second of two reports from this National Academy of Sciences committee. Report 1 discussed, among other topics, how to identify when National Flood Insurance Program (NFIP) premiums would result in a cost burden on policyholders, decisions that must be made by policy makers when designing an assistance program, and policy options for delivering assistance or for reducing premiums for all policyholders. In this report—Report 2—the task was to propose alternative approaches for evaluating affordability policy options. This second report describes analytical methods to evaluate affordability policy options and how the Federal Emergency Management Agency (FEMA) might expand its analytical capabilities; discusses data issues, which include data needs and availability of data; draws examples from a proof-of-concept pilot analysis conducted for a state with relatively rich data; and discusses how the data needs for a national affordability study might be addressed.

The first section in this chapter suggests some near-term analyses FEMA might complete as it is building its analytical capacity. The content of the remaining sections is the result of committee discussions and insights gained in the process of preparing Report 2. Those next sections include findings that add to or refine those in Report 1, Chapters 3 through 7.

NEAR-TERM ANALYSIS OF POLICY OPTIONS

FEMA is required to propose an affordability framework to Congress 18 months after submitting the affordability study.[1] In doing so, it must choose among numerous possible policy options. Ideally, FEMA would formulate alternatives for consideration, conduct an evaluation of the alternative options, and propose a preferred alternative. For FEMA to conduct an affordability analysis, both supporting data and an analytical platform are needed. Chapters 2 and 3 discussed the design of analytical procedures and the necessary supporting data to conduct an affordability analysis. In those chapters, specific observations and findings were presented. As a general matter, the findings in Chapters 2 and 3 suggest that FEMA will not be able to conduct a comprehensive analysis in the near term. There are analyses, however, that FEMA can undertake in the near term while building its analytical capacity in the longer term. First, based on Reports 1 and 2, some of the questions likely to be posed can be answered in a nonquantitative way. For example, one question (raised previously in Report 1) is, "Who might administer the [assistance] program?" This question might raise additional questions, such as, What legal authorities would the agency need to implement an alternative policy option or what other agencies would need to be partners in executing the option? The answers to such questions might affect the decision to pursue or not pursue an alternative policy option. FEMA may choose to narrow the range of options as it prepares answers to such questions.

Second, some alternatives might be initially removed from consideration (maybe to be reintroduced at a later date) based on a deductive and conceptual argument. For example, some of the options discussed in Report 1, such as disaster savings accounts, tax credits and deductions, and capping the NFIP responsibility to pay claims in high-loss years, might be put aside as viable near-term alternatives if the alternative would have little applicability to low-income property owners, if the alternative would require specialized legislation and execution by another agency, or if FEMA concluded that the alternative would have limited political acceptability.

Third, after this initial screening, some alternatives will remain candidates for inclusion in an affordability framework and, by Section 100236 of the Biggert-Waters Flood Insurance Reform Act of 2012 (BW 2012) direction, could be subject to quantitative analysis. Given FEMA's current

[1] The Homeowner Flood Insurance Affordability Act (HFIAA) 2014, Section 9, states that "Not later than 18 months after the date on which the Administrator submits the affordability study referred to in subsection (a), the Administrator shall submit to the full Committee on Banking, Housing, and Urban Affairs and the full Committee on Appropriations of the Senate and the full Committee on Financial Services and the full Committee on Appropriations of the House of Representatives the draft affordability framework required under subsection (a)."

analytical capabilities and available data, however, the immediate prospects for a quantitative analysis of formulated alternatives are limited. Nonetheless, NFIP operations are well understood and the policy questions FEMA is expected to answer are well understood. In fact, the North Carolina proof-of-concept pilot analysis illustrates that computational modules can be built to determine premiums, predict future claims, and make estimates of NFIP net revenues for a limited range of alternative policy options. Based on the North Carolina analysis, FEMA could begin the conceptual development of a microsimulation framework that represents the operation of the NFIP and that can be ready to evaluate affordability policy options as data gaps are filled (see Chapter 3).[2]

Fourth, some analyses can be completed with data now available, or with limited investments in database development. To illustrate:

- Some descriptive questions might be answered. As examples, how many policies will lose pre-flood insurance rate map (FIRM) subsidies under BW 2012; using algorithms developed for the North Carolina analysis, how many current NFIP polices are paying grandfathered rates; using American Community Survey (ACS) data, where are the census block groups that have a high percentage of policies losing pre-FIRM subsidized (PFS) rates on primary residences and have low median income or a high poverty rate relative to surrounding areas? This latter kind of analysis, perhaps with different criteria, might be a way to identify geographic areas of possible high cost burden.
- Some questions can be answered using existing or readily obtainable national data. For example, prior to BW 2012 about 10 percent of all policyholders (about 500,000) were paying pre-FIRM subsidized rates, and were also primary residences (see Report 1). Under BW 2012, as well as HFIAA 2014, these 500,000 properties over time will be required to pay NFIP risk-based rates. Some policyholders are not going to be cost burdened (whatever the definition) because (a) premiums will not rise substantially, (b) the policyholder has the ability to pay the higher premium, or both. However, FEMA has not been able to answer questions about how high these rates might go, how many of the approximately 500,000 policyholders will find the NFIP rates unaffordable, or how much an assistance program targeted to these policyholders might cost. Some initial analyses

[2] The North Carolina analysis found that the model-predicted premium for a given property often differed—sometimes substantially—from the premium being paid, as reported in the NFIP policy database. This demonstrates one challenge in developing a simulation model that can replicate how the NFIP operates in terms of calculating premiums and, in turn, for analyzing policy changes regarding how premiums are actually quoted by Write-Your-Own agents or how an assistance program might improve the affordability of flood insurance premiums.

may contribute to a better understanding of what may be the final answers to these questions.

A key data gap for such analysis is the absence of first-floor elevation data for pre-FIRM properties. Such data are now being requested for properties that were previously paying pre-FIRM subsidized rates. As authorized by the Homeowner Flood Insurance Affordability Act in 2014 (HFIAA 2014), FEMA is now increasing rates by 18 percent per year and will keep doing so until an elevation certificate is provided. FEMA might use the data from those certificates to impute first-floor elevations on structures for which elevations are not yet known.[3] Then, one near-term analysis would use current rating tables, available information on the properties and policies, and recently acquired data on first-floor elevations to estimate the range of premium increases. Knowing the size distribution of increases can be the basis for a policy discussion of whether the increases are "large" and for those that are deemed significant whether those policies are concentrated in particular areas. Also, knowing the total increase for all policies provides an upper-bound estimate of the new revenues that would flow to the NFIP (if all policies remained in force) and at the same time is an upper-bound cost estimate for a premium assistance program that would fully offset the increased cost for all PFS policyholders.

- Some questions can be answered using North Carolina data, building on the North Carolina analysis. For example, the costs of simply designed premium and mitigation grant assistance programs within North Carolina were estimated. More complex program designs could be formulated and evaluated for North Carolina.[4] Depending on study resources and schedule, the socioeconomic data gaps that now exist in North Carolina might be filled with a sample survey of flood-prone property owners in that state. Having such data would make it possible to compare the different measures of cost burden. Specifically, the cost burden definition in the North Carolina analysis was premium as a percent of coverage. The committee, in the following sections on cost burden, finds that this measure is not a measure of ability to pay and other measures of cost burden will need to be developed. If an income-referenced measure of cost burden is desired, imputing income characteristics of an aggregate

[3] For such an analysis, it would be important to capture the error introduced by imputation.

[4] Some options for the affordability framework might still be put aside for later study because the technical foundation for simulation of effects is lacking. For example, there are no available estimates of the relationship between premium levels and mitigation actions other than structure elevation in the NFIP rating tables (see Report 1).

census unit (e.g., a census block group) to individual policyholders using ACS data is not defensible. Therefore, a sample survey or a match to administrative income records within North Carolina may be required to obtain income data, although it may be unlikely that such a survey or records match could be undertaken in the near term. Alternatively, an analysis could use already available data on assessed property values for measuring cost burden, a possibility discussed in the next section. Such an analysis could examine, for example, how the number of property holders eligible for assistance and the amount of assistance that they receive varies when different percentage thresholds (for premium to property value) are used to identify who is cost burdened.[5] The results of any North Carolina analysis can be realized quickly and can make an important contribution to the design of an affordability framework. However, these results will be specific to the state and might have limited generalizability for making inferences to the nation, an important limitation that would have to be recognized.

- Fifth, the absence of some basic data for current policyholders (i.e., first-floor elevations of structures and household incomes of policyholders) and the lack of data for at-risk properties that are not currently covered by policies mean that the ability to use a microsimulation model to quantitatively analyze policy options presently will be limited in scope and prone to uncertainty. As FEMA uses the North Carolina proof-of-concept analysis to guide its model building it can, at the same time, use that effort to identify data needs, and strategies and priorities for data collection at the national level.

Finding 4.1. Some decision-relevant analyses can be completed with currently available analytical tools and data, or with limited investments in methods and database development. In the process of doing such analyses, FEMA also will make progress toward building analytical capacity to conduct more comprehensive policy analyses in the future.

FURTHER THOUGHTS AFTER REPORT 1

As Report 2 was being prepared, the committee's attention was on the analytical challenges to doing an affordability analysis. As ways to address those challenges were investigated, additional insights into the topics

[5] In addition, an analysis could assess the sensitivity of results to different behavioral assumptions about which policyholders would drop coverage when rates go up and would resume coverage when provided with assistance.

covered in each chapter of Report 1 were gained. As a result, the committee developed additional findings or refinements to those findings. These further findings that are relevant to the statement of task for Report 1 are reported in this section. To make the relationship to Report 1 clear, its chapter titles are used as the section headings below.

National Flood Insurance Pricing, Policies, and Premiums

Grandfathering

Grandfathered properties are those that were built in compliance with the flood hazard map in effect at the time of building construction, and the properties are allowed to maintain a lower flood insurance premium rate if a new map moves the property into a higher flood-risk zone or new base flood elevation. These policyholders would face increases if, as BW 2012 specified, grandfathering was no longer available and NFIP risk-based rates were to be paid. In addition, properties newly mapped in the special flood hazard areas (SFHAs) would be subject to the mandatory purchase requirement. For future NFIP-proposed changes pertaining to grandfathering, see footnote below.[6]

HFIAA 2014 reinstated grandfathering; however, Report 1 found that there is no reliable way to estimate the number of currently grandfathered policies and FEMA currently has no mechanism to identify grandfathered properties going forward. In addition, as was the case prior to BW 2012, HFIAA 2014 allowed grandfathered rates to transfer with the property by documenting that the structure was grandfathered by one of two ways. This was done by demonstrating the structure was built in compliance with the map at the time of construction and that continuous coverage has been maintained since the map change. Preferred risk policy (PRP) rates, however, cannot be grandfathered. When newly mapped into an SFHA, PRPs can apply for the newly mapped procedure. This gives formerly PRP properties 1 year of a PRP rate plus a reserved fund assessment and a federal policy fee, to comply with HFIAA 2014. For properties eligible for grandfathering, after this year they will be transitioned to a grandfathered rate, which would be a zone X (areas outside the 500-year floodplain) rate, even though they have now been mapped into an SFHA.[7]

Prior to BW 2012 and HFIAA 2014, all the NFIP rating tables included

[6] FEMA will be making program changes in early 2016. In doing so, they will be capturing additional information on grandfathered policies. A summary of program changes are available at http://nfipiservice.com/Stakeholder/FEMA7/W-15046.html.

[7] Information sourced from and additional information available at https://www.fema.gov/media-library-data/1428947341380-23a056704409206c86cc89ac72f9f070/FEMA-HFIAA_NewlyMappedFS_041015.pdf.

an explicit addition to premiums to account for forgone revenues from grandfathering. This cross-subsidy is being maintained by the NFIP and does support the BW 2012 expectation that NFIP revenues through time cover claims paid plus expenses (see Chapters 2 and 3 of Report 1). However, this cross-subsidy violates the actuarial principle that each property pays rates commensurate with its flood risk. Looking ahead, climate change, land development, and improved flood mapping mean that, in the future, some properties will be mapped into SFHAs when they are not currently, or will see higher base flood elevations. The owners of those properties will have the opportunity to pay grandfathered rates under HFIAA 2014 (in addition to those paying grandfathered rates prior to HFIAA 2014). The NFIP practice of increasing rates for all policyholders to account for revenue loss from grandfathering (i.e., cross-subsidizing rates) may result in an ever-increasing violation of the actuarial principle that rates paid should be in relation to risk.[8] Specifically, the result will be that for policies that are grandfathered, premiums will be too low, and for those who bear the cross subsidy, premiums will be too high.[9]

Finding 4.2. HFIAA 2014's reinstatement of grandfathering, which will perpetuate cross-subsidies in the NFIP, will result in the program increasingly violating actuarial pricing principles if flood risks increase in the future.

NFIP Risk-Based Premiums

Chapters 2 and 3 in Report 1 discussed NFIP rates and rate setting and the changes called for by BW 2012 and HFIAA 2014. With specific reference to rates and BW 2012, Congress instructed the NFIP to move toward flood insurance premiums that better reflected the full risks of flooding at a given location, following actuarial pricing principles. As noted, grandfathering was to be eliminated, but HFIAA reinstated that practice with the result that rates for those properties may not be risk based. However, PFS rates, even with HFIAA 2014, will be phased out. Another gap in attaining risk-based rates is pricing of policies that are outside of the SFHA. Outside

[8] Through time, some properties that had been paying grandfathered policies will either drop the policy or move to NFIP risk-based rates (for example, the policy lapsed and the property was sold). However, if risks increase through time that number may be small relative to the increase in newly grandfathered policies.

[9] One approach to making premiums affordable is to increase the number of communities participating in the Community Rating System (CRS). As discussed in Report 1, revenue losses from offering premium discounts in CRS communities are currently made up by cross-subsidization. If promoting CRS enrollment is an affordability option then, as with grandfathering, NFIP rates will increasingly violate actuarial pricing principles.

of the SFHA, FEMA does not rate based on elevation and, as a result, elevation data are not available for those properties. The result is that zone X and PRP rates are not risk based; specifically, those properties at much higher risk in these zones may be paying rates that are lower than their true risk and those at lower risk could be paying rates that are higher. BW 2012 does not specifically direct FEMA to review and modify PRP and zone X rates to make them risk based. One result is that the rates charged may continue to fail in providing accurate risk information on these properties to their owners.

For the NFIP to move toward risk-based rates for all policies, it will be necessary to take at least two actions:

- Obtaining first-floor elevation data for all insured properties including those outside the SFHA. New technologies can make collection of elevation data easier on a wide scale. In the future, communities or FEMA would be in a position to use a technique such as vehicle-based light detection and ranging (LiDAR), which is a remote sensing technology that measures distance, to obtain first-floor elevations for multiple properties instead of requiring each property owner to obtain an elevation certificate. This possibility was discussed in a recent National Research Council (NRC) report on tying flood insurance to flood risk for low-lying structures in the floodplain (NRC, 2015b) and has been used throughout the state of North Carolina.[10]
- Have flood maps depict the spectrum of risk that properties face rather than focusing only on the boundary of the SFHA. The existing focus on the boundary is an artifact of the program where mandatory insurance purchase requirements are defined by the location of the boundary. Digital flood insurance rate maps, however, have emphasized not only defining the boundaries of the SFHA, but also mapping risk zones within the SFHA. Delineating risk across the floodplain would enable FEMA to provide better information for local zoning and minimize possible neglect or misunderstanding of risk by property owners. Risk-based pricing will require maps to include new zones outside the SFHA that reflect the different likelihood and magnitude of flood insurance claims as a structure is further removed from the SFHA boundary. If rates changed continuously with flood risk across the landscape, there would not be a dramatic change in rates from just crossing the SFHA line.

[10] In areas where basements are common, LiDAR data will need to be supplemented with building information data.

Finding 4.3. Full implementation of BW 2012 will not result in NFIP risk-based rates for properties located outside the SFHA.

The Insurance Purchase Decision

Promoting Takeup Through Assistance Programs

Prior to BW 2012, the NFIP had about 5.3 million policies in force. Some number of those (that number cannot be determined) was the result of the mandatory flood insurance purchase requirement based on the policyholder having a federally backed mortgage and the insured property being located in a SFHA. Report 1 reviewed the limited evidence available, which suggested that some property owners were not purchasing insurance even when the purchase of flood insurance was mandatory. As rates increase, compliance with the mandatory purchase requirement may be further reduced, especially for those households where the costs of the premium exceed their ability to pay, given their income and other living expenses. To address both compliance and affordability concerns, an assistance program could focus on aid to policyholders who are required to purchase flood insurance. Such a focus could also include aid for currently uninsured households who would be required to pay NFIP risk-based premiums (or pay grandfathered premiums) in the future as a result of map changes.

Among the affordability concerns expressed in BW 2012 and HFIAA 2014 there was a desire to keep premiums affordable, not only to discourage dropping of mandatory coverage, but also to motivate the voluntary purchase of flood insurance. The rationale for having high takeup rates was discussed in Report 1. If the goal is to expand the number of policies in force both within and outside the SFHA, providing assistance may encourage voluntary purchase when the insurance premium exceeds a household's ability to pay, using some chosen criterion for defining cost burden.[11]

Finding 4.4. In designing an assistance program and considering the goal of increased flood insurance takeup, aid may need to be extended to property owners who are not required to purchase flood insurance.

[11] Willingness to pay may be the barrier to purchase. See Chapter 4 of Report 1 on takeup rates for further discussion. Further, from October 1, 2013, through September 30, 2014, flood insurance policy growth across the nation decreased by about 4 percentage points (FEMA, 2015). Policies in force across the nation were 5,568,642 and 5,350,887 in 2013 and 2014, respectively. Contributing factors could include premium rate increases from reform legislation adopted by Congress in 2012 and 2014.

BOX 4-1
Illustrative Example of Messaging to Homeowner

Your property at X location has a Y percent chance of being flooded in any given year. This amounts to a Z percent chance of at least one major flood event during the next 30 years. Given this risk, the NFIP risk-based premium for your property for 2016-2017 would be $W.[a] Due to provisions enacted by Congress, however, you will be charged only $V for your flood insurance.

[a] FEMA will implement HFIAA Section 28 (Clear Communications) starting April 2016 and will be providing a notice about flood risk versus how it is being rated.

Information Dissemination

Congress, in Section 9 of HFIAA 2014, directed that FEMA give consumers accurate information about the flood risk associated with their properties. If property owners are not asked to pay NFIP risk-based rates (for example, through grandfathering or the offering of non-elevation-rated rates), FEMA might still make estimates of those rates and inform the property owner about the premium discount they are receiving. To make such a calculation, however, FEMA needs access to first-floor elevation data and detailed flood risk maps.

With respect to disseminating information to homeowners, appropriate messaging would be helpful and could be included along with the annual premium letter. Any messaging could be piloted in focus groups and should draw from the literature (Kousky and Shabman, 2015). Where the specific information is available, the message could include components of an illustrative example shown in Box 4-1. Should specific information needed to estimate NFIP risk-based risks be lacking, a more general statement would be included in the annual premium letter.

Finding 4.5. Calculating and then informing policyholders of the NFIP risk-based rate may help address the direction of Congress that policyholders be provided with accurate information on the flood risks they face.

Affordability Concepts and a Framework for Assistance Program Design Decisions

The Ability to Pay Flood Insurance Premiums

BW 2012, Section 100236, states that FEMA

> shall enter into a contract under which the National Academy of Sciences, in consultation with the Comptroller General of the United States, shall conduct and submit to the Administrator an economic analysis of the costs and benefits to the Federal Government of a flood insurance program with full risk-based premiums, combined with means-tested Federal assistance to aid ***individuals who cannot afford***[12] coverage, through an insurance voucher program.

The phrase "cannot afford" can be understood as exceeding an individual's ability to pay an NFIP risk-based premium. This focus on ability to pay requires FEMA to define when such premiums impose a cost burden on an individual.

The ability of a property owner to bear a particular cost, such as a flood insurance premium, is often described in terms of some measure of household gross or net income.

For implementing an assistance program, individuals can be required to submit tax returns, W-2s, or other documents as proof of having a qualifying income. For policy simulations and other analytical purposes, however, analysts must rely on survey or administrative data, which often do not have measures of the specific income concept used by the assistance program. Therefore, other measures of income or proxies are often employed.

An alternative approach to defining ability to pay is the use of household wealth, rather than income. Wealth consists of the tangible and intangible assets owned by a household. It may be closely tied to income in some cases, but it is not the same as income. It can be argued that it takes income to produce wealth (e.g., investments) and that wealth can create income (e.g., return on investments). Monetary measures of wealth are generally expected to be positively correlated with income (high-wealth households tend to have high income; low-income households tend to have low wealth), but the correlation may be only moderately strong because there are sufficiently many low-income/high-wealth and high-income/low-wealth households.

Because it can take multiple forms, wealth is not always directly observable. Some components of wealth may vary quite slowly over time (e.g., value of housing stock) but other components can be more volatile (e.g., unrealized capital gains on investments, etc.).[13] For premium affordability, wealth can be seen as a proxy for income, or instead as a useful measure of ability to pay. There is a particular connection between household wealth and flood insurance that argues for the latter view. In the event of a flood, an uncompensated loss is, in the first instance, a loss of wealth. To the extent that a structure is repaired or rebuilt out of current income,

[12] Emphasis is not in the original text.

[13] With respect to difficulties in measuring wealth, see, for example, Boskin (1988) and Stiglitz (2015); on the treatment of capital gains, see Armour et al. (2013).

the loss of wealth is converted to a loss of disposable income. But if that is not the case, all or part of the damage remains as a loss of wealth. The role of flood insurance is to help the household avoid possible flood-related wealth losses, converting them to a much smaller and stable reduction in disposable income (the insurance premium).

Attempts to measure wealth encounter many of the same problems associated with income measurement. Although household wealth may consist of many different components, the principal component for those low-wealth households that might be the target of an affordability policy is the equity in the residence. A more readily available metric is the assessed valuation of real estate property, which includes not only the household's equity in the property, but also the debt-financed portion. The use of this metric as an affordability-related premium cap relies on the relatively strong correlation of home equity in lower-wealth households with household wealth[14] and the less well understood correlation of assessed valuation with home equity. Therefore, at least for the lower-wealth households usually associated with affordability issues, property value may be a useful indicator of ability to pay, especially given that data on property values are much more readily available than data on income or broader measures of wealth.

Defining Cost Burden for Assistance Program Design

Report 1 noted that there were many possible measures of cost burden and discussed three specific measures, two of which were related to an individual's income. Specifically, Report 1 discussed an income approach and a housing cost as percent of income approach to identify those who would be cost burdened by their NFIP premiums. Report 1 also discussed a "capped premium" approach based on the premium as a percent of flood insurance coverage, as suggested by HFIAA 2014, as a measure of cost burden. This report revisits the insurance coverage-based capped premium approach and, in light of the analytical needs and data gaps discussed in Chapters 2 and 3 of this report, introduces a new type of capped premium based on property value.

[14] 2011 data published by the Bureau of the Census (available at http://www.census.gov/people/wealth, "Table 1. Median Value of Assets for Households, by Type of Asset Owned and Selected Characteristics: 2011") showed that for all groupings of households with net worth (wealth) below $250,000, the median value of home equity was in the range of 60 to 74 percent of median net worth. Above $250,000, this share fell rapidly to less than 30 percent.

Cost Burden Measured by Premium as a Percent of Coverage

The capped premium approach based on the amount of flood insurance coverage purchased requires policy makers to specify a threshold percentage—premium relative to flood insurance coverage—at which the premium is judged to become cost burdensome.[15] The HFIAA 2014 legislation suggested that this threshold could be 1 percent. If this approach is chosen, policy makers will have to select that value or some other value. Using this criterion, a household whose risk-based premium exceeds the specified percentage of coverage would be deemed cost burdened and might be provided with assistance, potentially enough assistance to bring the premium down to the chosen threshold percentage.[16]

Consider a household which has (or is considering the purchase of) $100,000 in flood insurance coverage requiring an NFIP risk-based premium of $3,000. Using the criterion of 1.0 percent of total value of coverage for determining whether the household is cost burdened, the capped premium would be $1,000 and, if assistance is provided to eliminate the entire cost burden, the amount of assistance provided to this household would be between $3,000 and $1,000, or $2,000.

A property owner's income or wealth characteristics do not enter into this calculation. In the previous example ($100,000 of coverage for a premium of $3,000 and a cost burden threshold of 1 percent), a household with income of $500,000 would be considered just as cost burdened as a household with income of $50,000. Furthermore, if an assistance program provided assistance—a voucher, say—to eliminate the entire cost burden ($2,000 in this example), both households would receive the same amount of assistance. More generally, if assistance is provided to eliminate the entire cost burden measured by this particular approach, the amount of assistance is independent of income and only sometimes related to the wealth of a household.[17] In addition, this definition would make most assistance available to the highest-risk properties, since these are the policyholders for which the premium as a percentage of coverage would be the greatest. High-risk property owners may or may not face challenges with ability to pay.

[15] The committee was explicitly asked to evaluate and say if the approach (premium as a percent of flood insurance coverage) could be justified as a way to measure cost burden (affordability) in a letter to the committee from then-Senator Landrieu (see Appendix E for a copy of the letter).

[16] The amount of assistance is a separate decision that must be made by policy makers, as discussed in Report 1 (Chapter 6).

[17] Insurance coverage may reflect the asset value of the insured structure, a component of household wealth. However, coverage is limited to $250,000, so this association does not exist for more valuable structures. Also, some policyholders subject to the mandatory coverage provision may choose to purchase insurance for the (smaller) mortgage principal, rather than the asset value.

Finding 4.6. The use of premium as a percent of insurance coverage does not, by itself, satisfy the congressional directive to FEMA to consider providing "targeted assistance to flood insurance policyholders based on their financial ability."[18] Therefore, if ability to pay is the congressional concern, then FEMA will still need to develop a measure of cost burden based on policyholder income or wealth or both.

Cost Burden Measured by Premium as a Percent of Property Value

This approach defines the premium cap as a specified percentage of the assessed valuation of the insured real property.[19] Property value, which is a substantial component of total wealth for many households, especially low-wealth households, is used as a proxy for wealth. Wealth, in turn, is employed as a metric for ability to pay for flood insurance. Consider a property with an assessed valuation of $50,000 for the land and $100,000 for improvements. The household purchases a flood insurance policy with coverage of $100,000, at a cost of $3,000. Suppose that households are considered cost burdened if the insurance premium exceeds 0.67 percent of the property value; in this case, $1,000.[20] Assistance needed to lower the premium to the cap would be between $3,000 and $1,000, or $2,000.

Now suppose that a different (and perhaps higher-income) household has a home on an identical tract of land, but the assessed value of the improvements is $750,000. Total assessed valuation is $750,000 plus $50,000 = $800,000 and the NFIP risk-based premium for $250,000 of coverage is $5,000. (NFIP coverage is capped at $250,000 although the homeowner may be able to buy excess coverage on the private market.) The land value is still $50,000. The premium cap for $250,000 coverage is now 0.67 percent times $800,000, or $5,360. This property owner is not considered to be cost burdened and would receive no assistance.[21]

A principal advantage of this approach is that data on property values

[18] HFIAA, Sec. 9, (b) (2).

[19] This approach was not presented in Report 1.

[20] Because the cap is based on land value as well as structure value, 0.67 percent is used for comparability with the coverage-based cap. The actual percentage would be determined by FEMA, consistent with its directions from Congress to base assistance on financial ability as well as thorough empirical analysis.

[21] The alternative measure of cost burden discussed here takes the logic of the capped-premiums approach and uses property value rather than coverage for gauging the size of a premium. Yet another alternative would be to use property value like income in the income approach discussed in Report 1. For example, premiums could be deemed burdensome to those with relatively low property values (e.g., below some specified percentage of the median).

are relatively readily available.[22] This availability of assessed valuations for all structures in a floodplain, presently insured or not, creates another advantage—a microsimulation database that includes properties that are not currently insured but might become insured if premiums became more affordable. In the event that FEMA implements an assistance program based on property values, it will have the ability to anticipate assistance needs that may be associated with increased takeup rates. Along with its advantages, this approach has the problem of potentially granting unneeded assistance to low-wealth/high-income households, just as income-based cost burden measurements can lead to unneeded assistance for high-wealth/low-income households. Another problem with this wealth-based approach is not providing assistance to low-income households who have very limited wealth aside from the equity in their homes. This could be addressed through additional eligibility criteria or an appeals process.

Alternative Measures of Premium Cost Burden Compared

This report and the prior report (Report 1) present four different approaches to define the cost burden associated with NFIP premiums. Table 4-1 summarizes the four measures of cost burden, along with selected pros and cons for each.

Finding 4.7. For the purpose of implementing an assistance program, policy makers will decide whether they want to define cost burden with reference to income, housing costs in relation to income, premium paid in relation to property value, or some other measure. This decision can be informed by technical analysis of the alternatives, but the final selection is a policy judgment.

Loss of Property Value from Eliminating Pre-FIRM Subsidized Rates

Prior to passage of BW 2012, 20 percent of policyholders were paying less than NFIP risk-based premiums for properties located in the SFHA. BW 2012, as modified by HFIAA 2014, will increase those premiums until they reach the NFIP risk-based rate. The result is to increase the annual cost of ownership for the affected properties, which in turn should reduce the market price of the property. Any loss in market value will be incurred by the property owner at the time of the announced rate change and realized when the property is sold.

[22] In carrying out the planning process for enhancing its modeling capabilities, FEMA would still need to assess the resources required to obtain, prepare for use, and regularly update data on assessed property values.

TABLE 4-1 Advantages and Disadvantages of Four Measures of Cost Burden

Cost Burden Measures	Advantages	Disadvantages
Annual premium is unaffordable if it exceeds a specified percentage of insurance coverage. (Report 1 and Report 2)	• Requires no new data.	• Fails to reflect ability to pay, providing assistance to high-income and high-wealth households. • Assistance can go to high-risk properties, regardless of ability to pay. • No precedent for using such an approach for targeting assistance.
Annual premium is unaffordable if annual income is less than a specified amount. (Report 1)	• Income correlated with ability to pay for immediate needs. • Precedent for using income for means-tested programs.	• Burden on households and administrative cost to FEMA for collecting income information. • May give unnecessary assistance to low-income/high-wealth households.
Annual premium is unaffordable if total housing expenses, including premium, exceed a specified percentage of income. (Report 1)	• Takes into account both income and other housing expenses in assessing ability to pay for flood insurance. • The Department of Housing and Urban Development uses a similar metric that could be adopted for this purpose.	• Burden on households and administrative cost to FEMA for collecting data on income and housing cost. • May give unnecessary assistance to low-income/high-wealth households or high-income households with excessive housing expenses.
Annual premium is unaffordable if it exceeds a specified percentage of assessed real property value. (Report 2)	• Burden on households and administrative cost to FEMA are low as assessed property value is readily available. • Property value correlated with wealth, especially for low-wealth households.	• Does not account for income and thus may not fully reflect ability to pay. • Assessments can be many years old and may not reflect current market value. • May give unnecessary assistance to high-income/low-wealth households. • No precedent for using such an approach for targeting assistance.

Isolating premium increase effects from other determinants of market price will be difficult, even if the best data for making such a calculation were available. For example, suppose there is a rise in mortgage interest rates coincident with the rise in flood insurance premiums. Both would tend to reduce property values, but isolating the specific effect of either will be analytically difficult. Hedonic price analysis could, in principle, be employed to isolate the effect of subsidy removal on property prices. Some studies have documented a reduction in the price of property located in SFHAs after controlling for other determinants of housing prices (Harrison et al, 2001; Shilling et al., 1989). The property price effects of removing pre-FIRM subsidies may be harder to detect than those described in the literature, since data are not available on the specific properties that paid less than NFIP risk-based rates or how much the NFIP risk-based premium would have been. Indeed, the uncertainty about the level of the new rates will certainly influence the extent of capitalization of higher premiums that occurs.

One way to illustrate the effect is to use a simple capitalization calculation as might be done by a property assessor. For example, a $1,000-per-year increase in premiums from losing a pre-FIRM subsidized rate could result in a $20,000 reduction in property value (5 percent discount rate); a $2,000 increase might be $40,000. The loss in property value could be a small or large part of total asset value and could be a small or large part of the property owner's total wealth, recognizing that the property owner may have other assets.

These effects can be mitigated. One option would be to cap rates at a level less than NFIP risk-based rates for all properties that had pre-FIRM subsidized rates and also allow that cap on the premium to transfer with the property to all future owners, without regard to the future owners' ability to pay. On the other hand, if a property owner was allowed to pay a reduced annual premium, but not transfer that reduced premium to the next owner upon sale of the property, the value of the property will be reduced by the capitalized value of the increase in future NFIP premiums, as though the premium reduction had never occurred. This option would be contrary to the goals of BW 2012 to have property owners pay NFIP risk-based rates and would result in lost revenues to the NFIP unless offsetting increases in revenues were provided by the federal treasury or by cross subsidy. Another option would be for FEMA to buy the affected property at the market price that would be realized if the below NFIP risk-based rate was continued. FEMA could also provide a grant, allowing the property owner to implement flood damage reduction measures that would reduce NFIP risk-based rates to levels that would restore some or all of the property's market value. Both of these policy options would be challenging to implement and could require significant budget expenditures.

Finding 4.8. The negative effect on property values from allowing PFS rates to rise to NFIP risk-based rates is a market-driven reality but would be analytically difficult to isolate from other determinants of property price. A policy decision to compensate for some amount of property value loss may require significant public expenditure.

Cost Burden and Multifamily Properties

Multifamily rental apartments are a business and premiums for the building are paid by the property owner (landlord). Based on the data used for Report 1, about 70,000 apartment buildings nationwide were paying PFS rates. Following BW 2012 and HFIAA 2014, FEMA chose to define multifamily buildings as primary residences for purposes of applying the rate increases under HFIAA 2014. As rates increase, one possibility is that landlords may pass on the cost of increased NFIP premiums to renters, some of whom may be low income. Passing on the premium increase might make rents less affordable. The amount of rent increase that may be passed on, however, will depend on the number of comparable rental units in the same market area that would not have such increases. If comparable rental units are few, then landlords may be able to pass on the increased insurance costs.

Many of these flood insurance policies are for buildings concentrated in urban areas and were constructed in ways that make flood mitigation through elevation impractical. In lieu of elevating structures to mitigate flood loss, abandonment of commercial or rental use of the current first floor might be a mitigation action (to reduce premiums). In theory, this would impose a cost in the form of forgone rental income that may not be justified by premium savings. And even if justified by premium savings, vacating retail space (if that was the use) may diminish the mix and pattern of retail and residential space that defines "neighborhood character."

Finding 4.9. Because of variable building-specific circumstances and the limited number of polices affected, FEMA may choose to only extend assistance to landlords whose buildings include some to-be-defined percentage of low-income residents, provided that the landlord offers evidence, based on FEMA developed reporting requirements, that the savings were passed on to renters.

Policy Alternatives for an Affordability Strategy

Linking Mitigation with Premium Assistance

Report 1 recognized that linking mitigation with premium assistance can lead to property owners having a cost-effective combination of mitiga-

tion and insurance coverage. However, mitigation measures, particularly elevating structures, can be quite costly and a policyholder may not have the necessary up-front funds.[23] As a result, mitigation implementation costs might be initially paid for by taking a loan from a newly created mitigation loan program or by taking a commercial loan. Further, mitigation costs may also be paid for by a one-time governmental grant.

Report 1 also described how assistance might be offered for making premium payments, for paying for some or all of the mitigation that can lead to reduced premiums, or for a combination of the two. An annual assistance payment could be used for making an annual loan payment and paying some share of the NFIP risk-based premium (the financial logic was described in Report 1). Alternatively, it may be that the property owner receives a mitigation grant and then receives no further premium assistance, or minimal assistance, in future years.

One way to link premium assistance and mitigation is through provision of an annual payment that the property owner can use for paying the premium or for paying off the mitigation loan. If the property owner is to make this decision then the owner needs clear information on available options to reduce risk, how such measures could be financed, and the impact of adopting one or more measures on premium reductions. This type of information is not currently available to homeowners and would require FEMA to develop a new outreach and communication effort.

Another approach would be for the NFIP to make the calculation to determine the most cost-effective mitigation; NFIP does the calculation based on an analysis that the marginal dollar spent on mitigation justifies a reduction in premiums (and also restoration of property values). If assistance was offered, the NFIP could require that some level of mitigation be implemented. The assistance offered could be a combination of a mitigation grant, plus access to a loan with a commitment to an amount of assistance that would be used to make the annual loan payments and premium payment assistance for any remaining (after mitigation) cost burden imposed by paying the NFIP risk-based insurance premium. The argument for a mandatory linking, is that people lack the information to make a financial calculation about mitigation, so the assistance program makes it for them as an eligibility requirement.

Finally, there is a broader array of potential mitigation measures beyond elevation that merit consideration for reduced premiums. This includes measures for structures that cannot be elevated, such as row homes, as well as less costly measures that can still help lower flood losses. FEMA may wish to focus future studies on how to appropriately price a broader range

[23] Currently, policyholders can receive a reduction in flood insurance premiums for elevating their structure and a small set of other measures.

of flood mitigation measures. When there are no data to support premium reductions for measures across the country, a framework could be developed for communities to submit proof of the efficacy of such measures in lowering claims to obtain a flood insurance premium discount. This could be useful if such measures have the possibility of helping to lower premiums to more affordable levels while at the same time reducing flood losses.

Finding 4.10. Linking mitigation with premium assistance can lead to property owners having a cost-effective combination of mitigation and insurance coverage. Identifying that combination, however, requires complex calculations and the roles and responsibilities of FEMA in assisting with that calculation need to be assessed and, potentially, enhanced.

SUMMARY

HFIAA 2014 directs FEMA to propose an affordability framework for the NFIP. In doing so, it must evaluate affordability policy options. To do this, both supporting data and an analytical approach are needed. In the near term, FEMA can undertake analyses while building its analytical capacity over the long term.

As the committee focused on analytical challenges during preparation of Report 2, additional findings and refinements to findings that were presented in Report 1, specific to each of the chapters in Report 1, were identified.

Finding 4.1. Some decision-relevant analyses can be completed with currently available analytical tools and data, or with limited investments in methods and database development. In the process of doing such analyses, FEMA also will make progress toward building analytical capacity to conduct more comprehensive policy analyses in the future.

Finding 4.2. HFIAA 2014's reinstatement of grandfathering, which will perpetuate cross-subsidies in the NFIP, will result in the program increasingly violating actuarial pricing principles if flood risks increase in the future.

Finding 4.3. Full implementation of BW 2012 will not result in NFIP risk-based rates for properties located outside the SFHA.

Finding 4.4. In designing an assistance program and considering the goal of increased flood insurance takeup, aid may need to be extended to property owners who are not required to purchase flood insurance.

Finding 4.5. Calculating and then informing policyholders of the NFIP risk-based rate may help address the direction of Congress that policyholders be provided with accurate information on the flood risks they face.

Finding 4.6. The use of premium as a percent of insurance coverage does not, by itself, satisfy the congressional directive to FEMA to consider providing "targeted assistance to flood insurance policyholders based on their financial ability."[24] Therefore, if ability to pay is the congressional concern, then FEMA will still need to develop a measure of cost burden based on policyholder income or wealth or both.

Finding 4.7. For the purpose of implementing an assistance program, policy makers will decide whether they want to define cost burden with reference to income, housing costs in relation to income, premium paid in relation to property value, or some other measure. This decision can be informed by technical analysis of the alternatives but the final selection is a policy judgment.

Finding 4.8. The negative effect on property values from allowing PFS rates to rise to NFIP risk-based rates is a market-driven reality, but it would be analytically difficult to isolate from other determinants of property price. A policy decision to compensate for some amount of property value loss may require significant public expenditure.

Finding 4.9. Because of variable building-specific circumstances and the limited number of polices affected, FEMA may choose to only extend assistance to landlords whose buildings include some to-be-defined percentage of low-income residents, provided that the landlord offers evidence, based on FEMA-developed reporting requirements, that the savings were passed on to renters.

Finding 4.10. Linking mitigation with premium assistance can lead to property owners having a cost-effective combination of mitigation and insurance coverage. Identifying that combination, however, requires complex calculations, and the roles and responsibilities of FEMA in

[24] HFIAA, Section 9(b)(2).

assisting with that calculation need to be assessed and, potentially, enhanced.

A FINAL REFLECTION

Floodplains and coastal areas across the United States will continue to be inhabited. These areas will sustain damages from future riverine floods and coastal storms. The costs of these losses will be borne in three possible ways, or in some combination. Individual NFIP policyholders will bear location cost in the form of insurance premiums paid and damages falling within policy deductible amounts. The federal taxpayer might bear floodplain location costs if the federal treasury develops a premium assistance program, makes up for NFIP premium revenue shortfalls, or makes post-flood disaster assistance payments to individual households. Property owners and other floodplain or coastal zone inhabitants will bear costs for the losses that are uninsured or otherwise uncompensated.

An original intent of the NFIP was to replace disaster aid payment with flood insurance purchase to the maximum extent possible, shifting the cost of floodplain location onto those persons who occupy such places (Report 1, Charter 2). If this goal is to be pursued, then requests for premium assistance or mitigation grants and loans may increase due to future possible premium increases and from changes in flood risk stemming from changes in climate and changes in watershed runoff due to development. As an affordability framework is developed for the NFIP, FEMA and Congress will confront the central question, "Who will bear the costs of floodplain occupancy in the future?" With specific reference to the goal of "affordable premiums," that question will be answered in recognition of the available governmental budget for premium or mitigation assistance and the adherence to the actuarial principle of minimizing cross-subsidies within the NFIP.

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List of Acronyms

ACS	American Community Survey
BFE	Base flood elevation
BW	Biggert-Waters Flood Insurance Reform Act
CDBG	Community development block grant
CRS	Community Rating System
DFIRM	Digital flood insurance rate map
DHS	Department of Homeland Security
FEMA	Federal Emergency Management Agency
FIMA	Federal Insurance and Mitigation Administration
FIRM	Flood insurance rate map
GAO	Government Accountability Office
GIS	Geographic Information System
HEC	Hydrologic Engineering Center
HEC-HMS	Hydrologic Engineering Center-Hydrologic Modelling System
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HFIAA	Homeowner Flood Insurance Affordability Act
HUD	Department of Housing and Urban Development
LiDAR	Light detection and ranging

NAS	National Academy of Sciences
NCFMP	North Carolina Floodplain Mapping Program
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NRC	National Research Council
PFS	Pre-FIRM subsidized
PRP	Preferred risk policy
PUMS	Public use microdata sample
RDC	Research Data Center
Risk MAP	Risk Mapping Assessment and Planning
SBA	Small Business Administration
SFHA	Special Flood Hazard Area
USACE	U.S. Army Corps of Engineers
WYO	Write-Your-Own

Appendix A

Affordability of National Flood Insurance Program Premiums: Report 1 Summary

The National Flood Insurance Program (NFIP), established in 1968 and housed within the Federal Emergency Management Agency (FEMA), offers insurance policies that are marketed and sold through private insurers, but with the risks borne by the U.S. federal government. In July 2012, Congress passed the Biggert-Waters Flood Insurance Reform Act (BW 2012), which was designed to initiate several changes within the NFIP. A core principle of the 2012 legislation was to move toward an insurance program with NFIP risk-based premiums that better reflected expected losses from floods at insured properties.[1] This entailed eventual removal of discounts from NFIP policies known as "pre-FIRM [flood insurance rate map] subsidized" and "grandfathered" policies. Paying the claims for such policies contributed in part to the NFIP having to borrow from the U.S. Treasury to pay for claims after Hurricane Katrina and late storms. That debt was also a motivation for provisions in BW 2012 that directed FEMA to consider actions that had the potential to improve the financial foundation for the program through premium increases that would better reflect flood risks.

BW 2012 Section 100236 called for an "affordability study" from FEMA that would include "methods to aid individuals to afford risk-based premiums under the National Flood Insurance Program through targeted

[1] Some of the terms used in this report may be unfamiliar to the reader or may have been used in inconsistent ways in writing and testimony about the NFIP through the years. Terms specific to the NFIP were taken from FEMA to the extent possible, but other terms were developed by the committee to ensure their consistent use throughout the report. A List of Terms is included at the end of this report for the reader's convenience.

assistance rather than generally subsidized rates, including means-tested vouchers." The study was to inform the development of an affordability framework by FEMA to help inform NFIP policy decisions. However, implementation of BW 2012 rate increases was expected to take effect without awaiting the study and the development of an affordability framework, including an assistance program (see Appendix C for full language of BW 2012 Section 100236).

As BW 2012 went into effect, constituents from multiple communities expressed concerns about the elimination of lower rate classes, arguing that it created a financial burden on policyholders. Some concerns reflected the reality that purchase of the more expensive insurance was in some instances mandatory. Other concerns were based on expectations that higher premiums would depress home values, and on the question of whether higher premiums would thwart attainment of a long-standing objective of the NFIP to expand the number of properties covered by flood insurance. In response to these concerns, Congress passed the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA 2014). The 2014 legislation changed the process by which pre-FIRM subsidized premiums for primary residences would be removed and reinstated grandfathering. In addition, Section 9 of HFIAA 2014 once again called on FEMA to report to Congress with a draft affordability framework. Specifically, the legislation stated

> the Administrator shall prepare a draft affordability framework that proposes to address, via programmatic and regulatory changes, the issues of affordability of flood insurance sold under the National Flood Insurance Program, including issues identified in the affordability study required under Section 100236 of the Biggert-Waters Flood Insurance Act of 2012.

Section 100236 of BW 2012 mandated both the aforementioned FEMA affordability study and a study from the National of Academy of Sciences (NAS) to provide input into FEMA's work. In response, the National Research Council (NRC)[2] convened the Committee on the Affordability of National Flood Insurance Program Premiums. The statement of task guiding this NRC committee calls for two reports and explains the content of and distinctions between them:

> The first report, due in February 2015, will discuss the underlying definitions and methods for an affordability framework and describe the affordability concept and applications, and program policy options.

[2] The National Research Council is the working arm of the National Academies. The National Academies is the collective entity that includes the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), and the Institute of Medicine (IOM), along with the National Research Council. For more information, see http://nationalacademies.org.

The second report, due in September 2015, will propose alternative approaches for a national evaluation of affordability program policy options, based in part on lessons gleaned from a proof-of-concept pilot study to be guided by the NRC committee.

See Box 1-1, Chapter 1, for the full statement of task.

Consistent with its statement of task, Chapter 6 describes alternatives for determining when the premium increases resulting from BW 2012 would make flood insurance unaffordable and describes key design decisions and policy options for creating an assistance program. Chapter 7 discusses policy alternatives that may lower the cost of flood insurance for eligible households. To set the stage for Chapters 6 and 7, Chapter 2 describes the history of the NFIP, emphasizing the effects of that history on premium setting prior to BW 2012. Chapter 3 describes the NFIP pricing practices that were in place when BW 2012 was passed and how BW 2012 might increase premiums. Chapter 4 describes the demand for insurance and offers findings about the challenge of increasing the purchase of flood insurance policies, a long-standing objective of Congress for the NFIP. Chapter 5 identifies places in the nation where the effects of BW 2012 may be most pronounced.[3]

NATIONAL FLOOD INSURANCE PROGRAM HISTORY

Original proposals for a national flood insurance program date back to the 1950s. The original 1968 legislation that established the program, and implementation of the NFIP over the years that led up to passage of BW 2012, reflected an intent to make flood insurance part of a multifaceted national program for flood risk management. That intent, in turn, affected NFIP premium-setting practices that were used prior to BW 2012. The following findings are based on a review of that history.

- **From the inception of the NFIP, and continuing until BW 2012, Congress sought to achieve multiple objectives for the program. The objectives have been to (1) ensure reasonable insurance premiums for all, (2) have NFIP risk-based premiums that would make people aware of and bear the cost of their floodplain location choices, (3) secure widespread community participation in the program and substantial numbers of insurance policy purchases by property**

[3] This report does not attempt to specify programs or actions to promote flood insurance affordability, nor does it advise on how national flood risks might be reduced through insurance or other actions.

owners, and (4) earn premium and fee income that, over time, covers claims paid and program expenses. These objectives, however, are not always compatible, and at times may conflict with one another.

- **The premium-setting practices and procedures that were in place before Biggert-Waters 2012 reflected the multiple objectives of the NFIP, and in some cases reflected premium-setting practices that were put in place when the NFIP was created. BW 2012 increased the emphasis on setting NFIP rates that reflected flood risk, and on charging premiums that would cover claims paid and other related expenses.**

NATIONAL FLOOD INSURANCE PROGRAM POLICY PRICING AND EFFECTS OF BIGGERT-WATERS 2012

Well-established actuarial principles require that the combination of insurance premiums and other income sources yield revenues that will pay expected future claims and insurance program expenses (costs). These principles also hold that premiums for an individual policy, to the administratively feasible extent, should be based on expected claims plus fees for the policy. Further, the principles hold that there should be no cross subsidy whereby one group of policyholders has higher premiums so that others will have lower premiums. Finally, premiums should be no higher than necessary to ensure that these principles are met; regulation of private insurers is expected to limit premiums to costs of providing coverage plus a competitive return on invested capital. The NFIP, although not a private company, seeks to employ actuarial principles when setting premiums. However, historical precedent and congressional desire for premiums to be reasonable constrained application of these principles. BW 2012 sought to remove constraints on the NFIP's ability to follow actuarial pricing principles.

As a result, BW 2012 had the potential to increase premiums for three types of NFIP policies: NFIP risk-based, grandfathered, and pre-FIRM subsidized. Pre-FIRM subsidized policies have premiums that are less than those of NFIP risk-based policies for structures that were in place before a local FIRM was available. The NFIP realizes foregone revenues, relative to NFIP risk-based premiums, for this type of policy. To accommodate that reality, FEMA had adopted a revenue target whereby all premium income would equal claims paid on the historical average loss year (HALY). BW 2012 phases out this policy type; as a result, FEMA no longer uses the HALY in NFIP premium setting. The increases may be especially important for the 20 percent of properties that are eligible for pre-FIRM subsidized premiums.

The grandfathered premiums within the NFIP allow a given rating class to continue for a property even if a new FIRM may indicate a higher level of flood risk. To make up for revenue losses due to grandfathering, the NFIP

loads (adds a charge) to other policies in its policy base. Grandfathering—and as a result the cross subsidy—was phased out by BW 2012. HFIAA 2014 reinstated grandfathering.

The Community Rating System (CRS) is a FEMA program that encourages communities to adopt a variety of measures to help reduce flood risks. It allows discounted premiums for some properties when the community adopts one or more NFIP-prescribed flood risk management actions. CRS-discounted premiums are cross-subsidized by charges levied on all NFIP policyholders and were unaffected by BW 2012. The findings that follow are based on a review and discussion of NFIP pricing and the effects of BW 2012 and HFIAA 2014.

- **Prior to BW 2012, the NFIP goal was to offer reasonable premiums, but at the same time premiums were expected to follow actuarial principles and cover claims and expenses over the long term. As a matter of practice, the historical average loss year (HALY) became a total premium revenue target. Rates were set so that the total revenue from all policies was sufficient to replace the premium revenue loss from offering pre-FIRM subsidized polices.**
- **After BW 2012, use of HALY is to be replaced by charging all pre-FIRM properties NFIP risk-based rates. The increase in cost of insurance for policyholders as a result of phasing out pre-FIRM subsidized premiums and the resulting premium revenue increases to the program may be significant, but can be estimated only when additional data are available.**
- **HFIAA 2014 delayed but did not reverse the BW 2012 requirement to eliminate pre-FIRM subsided rates and to consider changes to NFIP risk-based rate-setting practices.**
- **HFIAA 2014 reinstated grandfathering. Revenue losses caused by offering grandfathered premiums, and by CRS discounted premiums, which continue to be offered, are expected to be offset by increasing premiums for all policies. Whether the revenue earned from these cross subsidies compensates for the forgone premium income is uncertain. If grandfathering or CRS discounting expands, the result will be that NFIP premiums increasingly violate the actuarial principle that premiums should be related to risk.**

INSURANCE DEMAND

A long-standing objective of the NFIP has been to increase purchases of flood insurance policies. The national flood risk management objective of widespread NFIP purchase was one motivation for keeping NFIP premiums reasonable, with the premise that the level of the premium determines the

willingness and ability to purchase flood insurance. However, property owners' decisions to purchase insurance include other considerations and influences unrelated to price. A review of the economics and behavioral sciences literature identified no single strategy that will increase purchase of NFIP policies.

- **The original NFIP legislation expected NFIP premiums to be priced at reasonable levels to promote voluntary purchase of NFIP policies. Empirical studies have found that premium prices may affect takeup rates although the size of that effect is small. The effect of the availability of disaster aid on insurance purchase decisions is uncertain.**
- **Studies have found that people may use intuitive thinking, as opposed to systematic consideration of the cost of premiums in relation to expected claim payments, when choosing to forgo insurance or to cancel an existing policy.**
- **The combination of acknowledgment of intuitive thinking and the limited effects of premiums on insurance purchase decisions suggests that lower premiums alone will not increase takeup rates substantially.**
- **Keeping NFIP premiums at reasonable levels can be part of any strategy to maintain compliance with mandatory purchase requirements and increase voluntary takeup rates. A multipart strategy to motivating purchase of NFIP policies can be designed using insights from the behavioral sciences literature.**

NATIONAL FLOOD INSURANCE PROGRAM POLICIES: LOCATIONS OF POTENTIAL AFFORDABILITY CHALLENGES

The NFIP policy database can be used to describe the locations of policies and areas of concentration. Knowing the location of all policies, pre-FIRM subsidized policies, and grandfathered policies could aid in formulating alternative strategies to provide assistance to households that find NFIP risk-based premiums to be affordable. Likewise, knowing the location of policies can provide insight into places where takeup rates are low.

- **About 60 percent of the approximately 5.5 million NFIP polices are in three states: Florida, Texas, and Louisiana. The rest are distributed widely throughout the nation. Any effects of BW 2012 therefore will be more concentrated in some places, but will appear throughout the nation.**
- **Available estimates of takeup rates suggest that they are low, especially outside special flood hazard areas. Meeting the long-standing goal of high takeup rates for flood insurance would therefore require a large increase in purchases.**

- **The extent and location of premium increases that might result from elimination of grandfathering can be determined by further analysis of the policy data, but cannot be estimated now.**
- **Slightly more than 1 million NFIP policyholders—or 19 percent of all policyholders—are paying pre-FIRM subsidized rates and will potentially see rate increases if the provisions of BW 2012 remain in effect. Pre-FIRM subsidized policies are found throughout the nation, but there are areas of concentration.**

DECISIONS WHEN DESIGNING ASSISTANCE PROGRAMS TO ENHANCE AFFORDABILITY

Both BW 2012 and HFIAA 2014 reflect concerns that NFIP risk-based premiums may be unaffordable for some households. FEMA is directed to review that possibility and suggest policy actions that would make premiums affordable for households that are financially burdened by the cost of flood insurance. If a premium is deemed unaffordable, the household paying that premium might receive assistance. The assistance may offset part of the cost of the premium, may be for mitigation actions that would reduce the risk and in turn the premium, or may be some combination of the two. HFIAA 2014 suggests that premiums are unaffordable if the premium exceeds 1 percent of the insurance coverage. Other measures of affordability can be defined by relating household income to the cost of housing or simply be based on when a household income is below a specified level. Whatever measure used, it will be only one consideration in the design of an assistance program. The form and amount of assistance provided, if any, will need to be determined.

- **There are no objective definitions of affordability. Although the concept is substantially subjective, the choice of a definition can be informed by research evidence and experience in administering means-tested programs that, for example, provide housing and other assistance.**
- **There are many ways to measure the cost burden of flood insurance on property owners and renters. Policymakers have to select which measure(s) will be used in the NFIP for targeting assistance to enhance flood insurance affordability. This decision is not amenable solely to technical analysis.**
- **To design a program that provides assistance in making flood insurance more affordable to NFIP policyholders, policy makers face several choices, including who will receive assistance, what type of assistance will be provided, how assistance will be provided, how much assistance will be provided, who will pay for assistance, and how an assistance program will be administered.**

- **The decisions that must be made in designing an affordability assistance program entail tradeoffs that will have to be resolved by policy makers.**

OPTIONS FOR DELIVERING ASSISTANCE TO ENHANCE FLOOD INSURANCE AFFORDABILITY

With passage of BW 2012, Congress asked FEMA to increase rates but at the same time to suggest ways to make premiums affordable through direct assistance programs that are based on ability to pay and means testing. Vouchers in particular were called out for attention. In addition to assistance with paying premiums, means-tested assistance can support mitigation that would reduce expected claims and premiums. Proposals for policies that might reduce the burden of premium payments or that might direct mitigation assistance toward households that qualify for assistance have been presented in legislation, in congressional testimony, and in professional literature. The committee reviewed the proposals and concluded the following:

- **The NFIP can strive for risk-based premiums while addressing affordability by implementing a combination of policy measures including means-tested mitigation grants, mitigation loans, vouchers, and encouragement of higher premium deductibles.**
- **Reforms to mitigation grant programs can be implemented so that means testing, as a replacement for the current benefit-cost test, is the basis for setting priorities for mitigation grant spending.**
- **A mitigation loan can make it financially attractive and feasible for low-income residents to invest in mitigation measures without having to rely on mitigation grants.**
- **Vouchers are an administratively simple way to direct payments to cost-burdened policyholders for use in paying premiums or for offsetting mitigation costs.**
- **The few mitigation measures that result in lower NFIP premiums tend to be expensive, such as elevating homes. As a result of BW 2012, FEMA will consider whether lower-cost mitigation of structures will result in lower premiums. Determining the effect of lower-cost mitigation on NFIP risk-based rates will require additional analyses.**
- **If Congress authorized supplements from the Treasury to be used for making NFIP claim payments in catastrophic-loss years, this could allow lower NFIP risk-based premiums and, in turn, less spending for assistance.**

- **Some policies that have been advanced to lower NFIP risk-based premiums for cost-burdened households either will not have that effect, or may not be easily accessed by cost-burdened policyholders. These include reducing administrative fees, disaster savings accounts, and income tax credits and deductions.**
- **Community measures can lower insurance premiums through mitigation actions that benefit clusters of structures and through the CRS. These might be particularly important in mitigation related to multifamily properties.**

Choosing among affordability policy options, alone or in combination, requires an evaluation of their effects not only on premiums for households for which NFIP risk-based premiums create a cost burden but on NFIP net revenues, expenditures from federal general revenues, and takeup rates. This committee's second report, to be published later in 2015, will suggest analytical protocols that FEMA might use to evaluate affordability policy options.

Appendix B

Recent Reports Produced by the Government Accountability Office and the Congressional Research Service

TABLE B-1 Recent studies undertaken and reports produced by the Government Accountability Office and the Congressional Research Service between 2011 and 2015.

Year	Produced By	Title	Key Questions and What Was Done
2011	GAO	FEMA: Action needed to improve the administration of the National Flood Insurance Program	Extent to which FEMA's management affect NFIP administration; lessons learned from canceling FEMA's attempt to modernize NFIP's insurance management system; limitations on FEMA's authority that could affect NFIP's financial stability.
2012	CRS[a]	National Flood Insurance Program: background, challenges, and financial status	NFIP borrowing, flood insurance premiums, repetitive loss, mandatory purchase, mapping, floodplain management, reauthorization of NFIP, and a suite of policy options.
2013	GAO	Flood Insurance: More information needed on subsidized properties	Number, location, and characteristics of properties that receive subsidized rates compared with full-risk rate properties; information needed to estimate the historic cost of subsidies and establish rates for previously subsidized policies that reflect risk; options to reduce the financial impact of remaining subsidized policies.
2013	CRS[a]	The National Flood Insurance Program: Status and remaining issues for Congress	Premium subsidies, repetitive loss, participation rates, hazard maps, floodplain management regulations, risk assessment and mapping, hazard and disaster assistance, options for managing and financing flood risk.
2014b	GAO	Flood Insurance: Forgone premiums cannot be measured and FEMA should validate and monitor data system changes	Examined the forgone premiums associated with subsidies during 2002-2013 along with data reliability issues.
2014a	GAO	Flood Insurance: Strategies for increasing private sector involvement	Conditions needed for private-sector involvement; strategies for increasing private-sector involvement.

TABLE B-1 Continued

Year	Produced By	Title	Key Questions and What Was Done
2014c	GAO	National Flood Insurance Program: Progress made on contract management but monitoring and reporting could be improved	Examined: FEMA's progress in updating its process for monitoring NFIP contractors since previous reports, the extent to which FEMA followed its monitoring process for the largest NFIP contractors.
2014d	GAO	Hurricane Sandy FEMA: FEMA has improved disaster aid verification but could act to further limit improper assistance	Discussed: the extent to which FEMA implemented controls to help prevent individuals and household program payments that are at risk of being improper or potentially fraudulent; the challenges FEMA and states faced obtaining information to help prevent individuals and household payments from duplicating or overlapping with other sources in its response to Hurricane Sandy.
2014e	GAO	Overview of GAO's past work on the NFIP	Summarized work on finances, premium setting, community and property owner participation, flood mapping, flood mitigation, administration, and information management.
2015a	GAO	Flood Insurance: Status of FEMA's implementation of the Biggert-Waters Act, as amended	Described: FEMA's management of the Act's implementation and associated challenges; the status of FEMA's implementation of selected requirements from the Act.
2015b	GAO	High-Risk Series: An update	GAO maintains a high-risk program to focus attention on government operations that it identifies as high risk due to their greater vulnerabilities. Five criteria for removal are leadership commitment, agency capacity, an action plan, monitoring efforts, and demonstrated progress.

[a]Author on both reports was R. O. King.

Appendix C

Biggert-Waters Flood Insurance Reform Act of 2012—Section 100236

SEC. 100236. STUDY OF PARTICIPATION AND AFFORDABILITY FOR CERTAIN POLICYHOLDERS

(a) FEMA STUDY.—The Administrator shall conduct a study of—

(1) methods to encourage and maintain participation in the National Flood Insurance Program;

(2) methods to educate consumers about the National Flood Insurance Program and the flood risk associated with their property;

(3) methods for establishing an affordability framework for the National Flood Insurance Program, including methods to aid individuals to afford risk-based premiums under the National Flood Insurance Program through targeted assistance rather than generally subsidized rates, including means-tested vouchers; and

(4) the implications for the National Flood Insurance Program and the Federal budget of using each such method.

(b) NATIONAL ACADEMY OF SCIENCES ECONOMIC ANALYSIS.—To inform the Administrator in the conduct of the study under subsection (a), the Administrator shall enter into a contract under which the National Academy of Sciences, in consultation with the Comptroller General of the United States, shall conduct and submit to the Administrator an economic analysis of the costs and benefits to the Federal Government of a flood insurance program with full risk-based premiums, combined with means-tested Federal assistance to aid individuals who cannot afford coverage, through an insurance voucher program. The analysis shall compare the

costs of a program of risk-based rates and means-tested assistance to the current system of subsidized flood insurance rates and federally funded disaster relief for people without coverage.

(c) REPORT.—Not later than 270 days after the date of enactment of this Act, the Administrator shall submit to the Committee on Banking, Housing, and Urban Affairs of the Senate and the Committee on Financial Services of the House of Representatives a report that contains the results of the study and analysis under this section.

(d) FUNDING.—Notwithstanding section 1310 of the National Flood Insurance Act of 1968 (42 U.S.C. 4017), there shall be available to the Administrator from the National Flood Insurance Fund of amounts not otherwise obligated, not more than $750,000 to carry out this section.

Appendix D

Homeowner Flood Insurance Affordability Act of 2014—Section 16

SEC. 16. AFFORDABILITY STUDY AND REPORT

(a) STUDY ISSUES.—Subsection (a) of section 100236 of the Biggert-Waters Flood Insurance Reform Act of 2012 (Public Law 112–141; 126 Stat. 957) is amended—

(1) in paragraph (3), by striking "and" at the end;

(2) in paragraph (4), by striking the period at the end and inserting a semicolon; and

(3) by adding at the end the following new paragraphs:

"(5) options for maintaining affordability if annual premiums for flood insurance coverage were to increase to an amount greater than 2 percent of the liability coverage amount under the policy, including options for enhanced mitigation assistance and means-tested assistance;

"(6) the effects that the establishment of catastrophe savings accounts would have regarding long-term affordability of flood insurance coverage; and

"(7) options for modifying the surcharge under 1308A, including based on homeowner income, property value or risk of loss.".

(b) TIMING OF SUBMISSION.—Notwithstanding the deadline under section 100236(c) of the Biggert-Waters Flood Insurance Reform Act of 2012

(Public Law 112–141; 126 Stat. 957), not later than 18 months after the date of enactment of this Act, the Administrator shall submit to the full Committee on Banking, Housing, and Urban Affairs and the full Committee on Appropriations of the Senate and the full Committee on Financial Services and the full Committee on Appropriations of the House of Representatives the affordability study and report required under such section 100236.

(c) AFFORDABILITY STUDY FUNDING.—Section 100236(d) of the Biggert-Waters Flood Insurance Reform Act of 2012 (Public Law 112–141; 126 Stat. 957) is amended by striking "$750,000" and inserting "$2,500,000".

Appendix E

Biographical Sketches of Committee Members

LEONARD A. SHABMAN, *Chair,* joined Resources for the Future in 2002 as a resident scholar after three decades on the faculty of Virginia Polytechnic Institute and State University. His research and communications efforts focus on programs and responsibilities for flood and coastal storm risk management, design of payment for ecosystem services programs, and development of evaluation protocols for ecosystem restoration and management projects, especially in the Everglades, coastal Louisiana, and Chesapeake Bay. Among the specific topics related to those themes are applied research on permitting under Section 404 of the Clean Water Act, creating market-based incentives for water quality management and provision of ecosystem services, and design of collaborative water management institutions. He served for 8 years on the National Research Council Water Science and Technology Board, has chaired or been a member of several National Research Council (NRC) committees, and has been recognized as an Associate of the National Academy of Sciences. Dr. Shabman received a Ph.D. degree in agricultural economics from Cornell University.

SUDIPTO BANERJEE is professor and chair of biostatistics at the University of California, Los Angeles. His research, dissertation advising, and mentoring activities focus on statistical modeling and analysis of geographically referenced datasets, Bayesian statistics, the interface between statistics and geographical information systems, and statistical computing. He received a National Institutes of Health challenge grant in 2009. In the same year he was honored with the Abdel El Sharaawi Award of the International Environmetrics Society, and in 2011 he received the Mortimer Spiegelman

Award of the American Association of Public Health. He is an elected fellow of the American Statistical Association and an elected member of the International Statistical Institute. Dr. Banerjee received a B.S. degree from Presidency College and an M.S. degree in statistics from the Indian Statistical Institute, both in Calcutta, and M.S. and Ph.D. degrees in statistics from the University of Connecticut.

JOHN J. BOLAND is an engineer and economist and is professor emeritus in the Department of Geography and Environmental Engineering of Johns Hopkins University. His fields of research include water and energy resources, environmental economics, benefit-cost analysis, and public utility management. Dr. Boland has studied resource problems in more than 20 countries, has published more than 200 papers and reports, and is a coauthor of two books on water demand management and three more on environmental management. He has served on several NRC committees and is a founding member and past chair of the Water Science and Technology Board. Dr. Boland received a Ph.D. degree in environmental economics from Johns Hopkins University.

PATRICK L. BROCKETT is the Director of the Risk Management and Insurance Program and the Gus S. Wortham Memorial Chair in Risk Management and Insurance of the University of Texas at Austin. He conducts research in risk management and insurance, financial risk, actuarial science, decision analysis, management science and operations management and research, statistical analysis, and business applications. Dr. Brockett is an elected member of the International Statistical Institute and a fellow of the Institute for Risk Management, the American Statistical Association, the Institute of Mathematical Statistics, and the American Association for the Advancement of Science. In 2006, he received the American Risk and Insurance Association Outstanding Achievement Award for furthering the science of risk management through promotion of education, research, and communication during his tenure as editor of the *Journal of Risk and Insurance*. He is the editor of the *North American Actuarial Journal*. Dr. Brockett received his B.S. degree in mathematics from California State University-Long Beach, and his M.S. and Ph.D. degrees in mathematics from the University of California, Irvine.

RAYMOND J. BURBY is professor emeritus of city and regional planning at the University of North Carolina at Chapel Hill. He is a fellow of the American Institute of Certified Planners and has received the biannual Distinguished Educator Award of the Association of Collegiate Schools of Planning. He is the author, co-author, and editor of 14 books and more than 150 publications on hazard mitigation, environmental management,

and land use planning and management. Dr. Burby served as co-editor of the *Journal of the American Planning Association* from 1983 to 1988 and was an associate editor of the *Natural Hazards Review*. He has served on NRC committees on pipeline safety, dam and levee safety, and lessons from Hurricane Katrina. His research interests include federal and state hazard mitigation planning mandates, integration of hazard mitigation plans with local comprehensive plans, and improvements in code enforcement to create disaster resilient communities. Dr. Burby received an A.B. degree in government from George Washington University and M.R.P. and Ph.D. degrees in city and regional planning from the University of North Carolina at Chapel Hill.

SCOTT A. EDELMAN is the director of the AECOM Water Resources team for North America. He has 32 years of experience devoted to flood insurance studies and floodplain mapping. Mr. Edelman has been responsible for overseeing AECOM's floodplain mapping and mitigation work for the Federal Emergency Management Agency and many state and local partners, including Georgia, Alabama, North Carolina, South Carolina, Mississippi, Maryland, and California. He was a contributor to such FEMA projects as the initial Multi-Year Flood Hazard Identification Plan, developing initial concepts for the Mapping Information Platform, and contributing to Guidelines and Specifications. He has managed riverine and coastal flood insurance studies for the past 23 years, including more than 15,000 digital Flood Insurance Rate Map panels, which represents approximately 10 to 15 percent of the floodplain maps in the nation. Mr. Edelman is a licensed professional engineer in five states. He served on the NRC Committee on Floodplain Mapping Technologies. He received his B.S. degree in civil engineering from Pennsylvania State University.

W. MICHAEL HANEMANN, NAS, is a professor of economics and holds the Wrigley Chair in Sustainability at the School of Sustainability of Arizona State University. He is also a professor in the graduate school and Chancellor's Professor Emeritus in the Department of Agricultural and Resource Economics of the University of California, Berkeley. Elected to the National Academy of Sciences in 2011, Dr. Hanemann is an environmental economist who works in nonmarket valuation, water economics and policy, and climate change. A focus of his current research on water is the distinctive physical and institutional features of water, the evolution of water rights and institutions in the American West, legacy effects with respect to obstacles to promoting better uses of water, balancing extractive versus in-stream uses of water, and adapting water rights to face the challenges of climate change. He is a lead author and coordinating lead author in Working Group III of the Intergovernmental Panel on Climate Change

Fifth Assessment Report. He received his Ph.D. degree in economics from Harvard University.

CAROLYN KOUSKY is a fellow at Resources for the Future in Washington, D.C. She has published numerous articles, reports, and book chapters on the economics and policy of natural disasters and disaster insurance markets. Her research focuses on decision making under uncertainty, natural resource management, and individual and societal responses to natural disaster risk. She has evaluated the demand for natural disaster insurance, the functioning of the National Flood Insurance Program, policy responses to potential changes in extreme events with climate change, and how individuals learn about risk. She is the recipient of the 2013 Tartufari International Prize of the Accademia Nazionale dei Lincei. She received a B.S. degree in Earth systems from Stanford University and a Ph.D. degree in public policy from Harvard University.

HOWARD C. KUNREUTHER is the James G. Dinan Professor of the University of Pennsylvania's Wharton School of Business and co-director of the Wharton Risk Management and Decision Processes Center. He has a long-standing interest in how society can better manage low-probability, high-consequence events related to technologic and natural hazards. Dr. Kunreuther is a Fellow of the American Association for the Advancement of Science and a Distinguished Fellow of the Society for Risk Analysis, having received the society's Distinguished Achievement Award in 2001. He recently served on the NRC committee on Increasing National Resilience to Hazards and Disasters. He is a coordinating lead author of the upcoming report, *Integrated Risk and Uncertainty Assessment of Climate Change Response Policies,* to be released by the Intergovernmental Panel on Climate Change. His most recent book is *Insurance and Behavioral Economics: Improving Decisions in the Most Misunderstood Industry* (with M. Pauly and S. McMorrow, 2013). Dr. Kunreuther received his Ph.D. degree in economics from the Massachusetts Institute of Technology.

SHIRLEY LASKA is a professor emerita of sociology and was founding director of the Center for Hazards Assessment, Response and Technology of the University of New Orleans. She has been conducting research on the social-environmental interface of natural and technological hazards, and disaster response, for 25 years. Her work includes studies of residential flood mitigation, hurricane response, coastal land loss effects, coastal fisheries, community risk assessment and risk management for coastal hazards, and evacuation of the vulnerable. Since Hurricane Katrina her work has focused on lessons learned from the event, especially in the realm of community recovery and hazard resiliency. Dr. Laska is the 2008 recipient

of the American Sociological Association's Public Understanding of Sociology Award for her collaboration with physical scientists and presentations on Katrina and Rita impacts. She was a member of the NRC Committee on Integrating Dam and Levee Safety and Community Resilience. She received her Ph.D. degree in sociology from Tulane University.

DAVID R. MAIDMENT is the Hussein M. Alharthy Centennial Chair in Civil Engineering of the University of Texas at Austin, where he has been on the faculty since 1981. His research focuses on surface water hydrology, particularly in the application of geographic information systems to hydrology, and floodplain mapping. He has chaired or been a member of 10 NRC committees, including the Committees on FEMA Flood Maps and FEMA Floodplain Mapping Technologies. Dr. Maidment has received awards for outstanding contributions to hydrology from the American Society of Civil Engineers, the American Water Resources Association, and the American Institute of Hydrology. He received his Ph.D. degree in civil engineering from the University of Illinois at Urbana-Champaign.

DAVID I. MAURSTAD is a director and senior vice-president with Optimal Solutions and Technologies, Inc., Washington, D.C., which provides management consulting, integrated information technology, engineering services, and business process outsourcing. He previously served as director of water policy and planning for a nationally recognized engineering firm that specialized in flood mapping and floodplain management. He has more than 30 years of experience with the private insurance industry and federal, state, and local government. In June 2004, he was appointed by President George W. Bush to lead some of the nation's prominent multihazard risk reduction programs. In that role, he was the federal insurance administrator charged with management of FEMA's National Flood Insurance Program. He previously served as director of FEMA Region VIII from 2001 to 2004, coordinating federal, state, tribal, and local management of emergencies through planning, preparedness, mitigation, response, and recovery. Mr. Maurstad is a former lieutenant governor and state senator of Nebraska and served as mayor of Beatrice, Nebraska. He received his B.S. degree in business administration and his M.B.A. degree from the University of Nebraska.

ALLEN L. SCHIRM is the director of methods and a senior fellow of Mathematica Policy Research in Washington, D.C. His principal research interests include small-area estimation, census methods, and sample and evaluation design, with application to studies of child well-being and welfare, food and nutrition, and education policy. For the NRC Committee on National Statistics, he chaired the Panel on Estimating Children Eligible

for School Nutrition Programs Using the American Community Survey and was a member of the Panel on the Design of the 2010 Census Program of Evaluations and Experiments, the Panel on Research on Future Census Methods, the Panel on Formula Allocations, and the Panel on Estimates of Poverty for Small Geographic Areas. He is a fellow of the American Statistical Association and a former chair of its Social Statistics Section. Dr. Schirm received an A.B. degree in statistics from Princeton University and a Ph.D. degree in economics from the University of Pennsylvania.

Appendix F

Letter to the Committee from Senator Mary L. Landrieu, Louisiana

MARY L. LANDRIEU
LOUISIANA

United States Senate
WASHINGTON, DC 20510–1804

March 27, 2014

Mr. Jeffrey Jacobs
Director
Water Science and Technology Board
National Research Council
500 Fifth Street NW
Washington, DC 20001

Dear Members of the National Research Council Committee on the Analysis of Costs and Benefits of Reforms to the National Flood Insurance Program—Phase 1:

Thank you and your fellow National Research Council committee members for donating your time and energy to the Analysis of the Costs and Benefits of the National Flood Insurance Program (NFIP) authorized by the Biggert-Waters Flood Insurance Reform and Modernization Act of 2012 (P.L. 112-141). This review shall include an economic analysis that compares and contrasts the merits of charging full risk-based premiums versus the subsidized flood insurance policies that were a centerpiece of the program prior to 2012. The review shall assess the impacts each approach will have on Federal disaster response costs and the budget at large, and I appreciate this opportunity to offer my perspective on this important study.

The Federal Emergency Management Administration (FEMA) estimates that the NFIP saves American taxpayers $1.6 billion annually in avoided disaster response costs. Despite the fact that between 1978 and 2011, the program experienced just nine loss years in which flood loss payments exceeded premiums written, Section 100211 of Biggert-Waters gives FEMA the conflicting mandate of including catastrophic loss years when calculating average historical loss years in accordance generally accepted actuarial principles. I encourage the Committee to consider the viability and actuarial soundness of this methodology in the affordability study.

Section 7 of the Homeowner Flood Insurance Affordability Act (P.L. 113-89) directs the Administrator of FEMA to strive to minimize the number of policies with annual premiums that exceed one percent of the total coverage provided by the policy and report any instances in which premiums exceed that threshold. Section 16 of the same bill amends FEMA's portion of the affordability study authorized under Biggert-Waters to include additional criteria such as the options for maintaining affordability if annual premiums exceed two percent of the liability coverage provided by the policy. It is clear that Congress has significant concerns about the overall affordability of flood insurance, and I urge this Committee to specifically evaluate the viability of different affordability thresholds as defined by the percentage each premium represents of the total coverage provided by the policy.

During a March 12, 2014 hearing of the U.S. Senate Committee on Appropriations Subcommittee on Homeland Security, Secretary Jeh Johnson acknowledged the importance of affordability and overall participation in the long-term solvency of the National Flood Insurance Program. As my colleague Congressman Steve Scalise (R-LA) said so eloquently on the floor of the House, "Sending somebody a $10,000 or a $20,000-a-year bill on a $200,000 house that never flooded is not an actuarially sound rate. It's a death sentence." While we have anecdotal data indicating poor compliance rates around 60% with the NFIP mandatory purchase requirement, it is imperative that this Committee provides reliable data about compliance and market penetration in this study to ensure the risk pool can sustain the program's liabilities.

Lastly, I represent many coastal communities that are intimately familiar with flood risks and actively invest their own resources in mitigating their exposure to floods. Although FEMA has initiated a pilot program that is designed to give these communities credit for existing flood protection infrastructure, as it stands today, a $450 million, 40 mile levee that has never failed was literally wiped off the map in the new FEMA flood map was released for Lafourche Parish in 2008. This Committee should consider programs and initiatives that incentivize local investments in mitigation and reward communities that take a proactive approach to flood protection.

Over 55% of our nation's Global Domestic Product is produced by the 15% of U.S. counties that are located directly on open ocean, the Great Lakes or in coastal floodplains. The National Flood Insurance Program was created with the explicit goal of making flood insurance available on reasonable terms and conditions so that people could live where they needed to work to power our nation's economy. While I am proud of the progress we have made with the Homeowner Flood Insurance Affordability Act (P.L. 113-89), nothing is perfect. Nothing is permanent. We must remain vigilant and ensure people get the relief they need and deserve. I appreciate the opportunity to engage with the Committee and look forward to a timely delivery of the Phase I report later this year.

With warm regards, I am

Sincerely,

Mary L. Landrieu
United States Senator

MLL:jwk

Appendix G

American Community Survey 5-Year Data Products

Tables of ACS 5-year data for census tracts and block groups are available through the American FactFinder web site (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml). Block group tables are fewer in number and less detailed than the full table set, both to protect the confidentiality of respondents and because of small sample sizes (and, thus, imprecision) at the block group level. Table G-1 below lists some of the 5-year tables of potential interest for the Federal Emergency Management Agency, indicating which ones are available for census tracts only and which for both tracts and block groups.

TABLE G-1 Selected Tables Available for ACS 5-Year Data Products

Table Number	Table Title (Universe in parentheses except where part of table title)	Available for Census Tracts	Also Available for Block Groups
B11001	Household type, including living alone (households)	Yes	Yes
B11011	Household type by units in structure (households)	Yes	No
B11012	Household type by tenure (owner/renter) (households)	Yes	Yes
B11016	Household type by household size (households)	Yes	Yes
C17002	Ratio of income to poverty level (persons in poverty universe)	Yes	Yes
B17019	Poverty status of families by household type by tenure	Yes	No
B17026	Ratio of income to poverty level (families)	Yes	No
B19001	Household income (households)	Yes	Yes
B19013	Median household income (households)	Yes	Yes
B19051	Earnings for households	Yes	Yes
B19054	Interest, dividends, or net rental income for households	Yes	Yes
B19055	Social Security income for households	Yes	Yes
B19056	Supplemental Security Income for households	Yes	Yes
B19057	Public assistance income for households	Yes	Yes
B19059	Retirement income for households	Yes	Yes
B19081	Mean household income of quintiles (households)	Yes	No
B19301	Per capita income (persons)	Yes	Yes
B22003	Receipt of food stamps by poverty status (households)	Yes	No
B25002	Occupancy status (housing units)	Yes	Yes
B25003	Tenure (owner/renter) (occupied housing units)	Yes	Yes
B25004	Vacancy status, housing units (vacant units)	Yes	Yes
B25005	Vacant—current residence elsewhere (vacant units)	Yes	No
B25021	Median number of rooms by tenure (occupied housing units)	Yes	Yes
B25024	Units in structure (housing units)	Yes	Yes
B25032	Tenure by units in structure (occupied housing units)	Yes	Yes
B25034	Year structure built (housing units)	Yes	Yes
B25035	Tenure by year structure built (occupied housing units)	Yes	Yes
B25037	Median year structure built by tenure (occupied housing units)	Yes	Yes
B25042	Tenure by bedrooms, housing units (occupied housing units)	Yes	Yes

TABLE G-1 Continued

Table Number	Table Title (Universe in parentheses except where part of table title)	Available for Census Tracts	Also Available for Block Groups
B25049	Tenure by plumbing facilities (occupied housing units)	Yes	No
B25053	Tenure by kitchen facilities (occupied housing units)	Yes	Yes
B25058	Median contract rent (renter-occupied housing units paying cash rent)	Yes	Yes
B25064	Median gross rent (renter-occupied housing units paying cash rent)	Yes	Yes
B25078	Median value (owner-occupied housing units)	Yes	Yes
B25081	Mortgage status (owner-occupied housing units)	Yes	Yes
B25091	Mortgage status by selected monthly owner costs, as a percent of income	Yes	Yes
B25092	Median selected monthly owner costs, as a percent of income	Yes	Yes
B25097	Mortgage status by median value (owner-occupied housing units)	Yes	No

Appendix H

Tables of Data Fields Found in the NFIP Policy Database October 2013 Version

TABLE H-1 Summary of NFIP Policy Database Field Completeness

Policy Data Category	Data Assessment
Building Characteristics	Data available for most of the policy records
Elevation Data	Up to 60% of records have null values for some fields
General Policy Info	Data available for most of the policy records
Location	Data available for most of the policy records. Some secondary fields in this category are not well populated
Miscellaneous	Data are very well populated. Some secondary fields in this category are not well populated
Policy Term Info	Data available for most of the policy records
Premium / Coverage Info	Data available for most of the policy records. Some secondary fields in this category are not well populated
Risk Rating Factor	Data available for most of the policy records. Some secondary fields in this category are not well populated

TABLE H-2 NFIP Policy Database Field Completeness

Policy Field Name	Policy Feed Description	Comments on Policy Field Values	Data Category
COMPANY_CD	Insurance Company Code	All records populated but approx. 2% of records have invalid values	General Policy Info
POL_NO	Policy Number	All records populated	General Policy Info
END_EFF_DT	Endorsement Effective Date	All records populated	Policy Term Info
T_PREMIUM	Total Annual Premium	Almost all records populated; less than 1% null	Premium / Coverage Info
N_EXP_CST	Expense Constant—NFIP Calculated	All records populated	Miscellaneous
POLICY_FEE	Federal Policy fee	All records populated	Miscellaneous
PREM_PAY_I	Premium Payment Indicator	Approx. 73% of records have null values	Miscellaneous
POL_EFF_DT	Policy Effective Date	All records populated	Policy Term Info
N_POL_TERM	NFIP Number of Policy Terms	Almost all records populated; less than 1% null	Policy Term Info
W_POL_TERM	Write Your Own Number of Policy Terms	Almost all records populated; less than 1% null	Policy Term Info
POL_STATUS	Policy Status	All records populated	General Policy Info
REGION	FEMA Region	All records populated	Location
PROGRAM	Community's Program Type (Regular or Emergency)	All records populated	General Policy Info
OCCUPANCY	Occupancy Type	All records populated	Risk Rating Factor
T_COV_BLDG	Total Amount of Insurance Coverage for Building	All records populated	Premium / Coverage Info
T_COV_CONT	Total Amount of Insurance Coverage for Contents	All records populated	Premium / Coverage Info

TABLE H-2 Continued

Policy Field Name	Policy Feed Description	Comments on Policy Field Values	Data Category
ROLLOVER	Rollover Indicator	Almost all records populated; less than 1% null and/or invalid	General Policy Info
ORG_NB_DT	Original Policy Effective Date (New Business Date)	All records populated	Policy Term Info
CUR_POL_EF	Current Policy Effective Date	All records populated	Policy Term Info
COMMUNITY	Concatenated Number of Community No. + Panel + Suffix	All records populated	Location
PANEL_SUF	DFIRM Panel Suffix	Almost all records populated; less than 1% null and/or invalid	Location
CONDO_UNIT	Number of units covered by condo policy	All records populated	Building Characteristics
RATE_METHO	Type of Risk Rating Method	Almost all records populated; less than 1% null and/or invalid	Risk Rating Factor
POL_EXP_DT	Policy Expiration Date	All records populated	Policy Term Info
FIRST_NAME	Policy Holder First Name	Almost all records populated; less than 1% null	General Policy Info
LAST_NAME	Policy Holder Last Name	All records populated	General Policy Info
NAME	Name (N) or Descriptive (D) Property Information	Almost all records populated; less than 1% null	General Policy Info
ADDRESS1	Secondary Address Field	Approx. 94% of records have null values	Location
ADDRESS2	Primary Address Field	Almost all records populated; less than 1% null and/or invalid	Location
CITY	City	Almost all records populated; less than 1% null and/or invalid	Location
STATE	State (2 Letter Abbreviation)	All records populated	Location

continued

TABLE H-2 Continued

Policy Field Name	Policy Feed Description	Comments on Policy Field Values	Data Category
ZIP1	7 Digit Zip	All records populated	Location
ZIP2	4 Digit Zip Extension	Approx. 7% have null and/or invalid records	Location
ADDRESSKEY	Address Key	Almost all records populated; less than 1% null and/or invalid	Location
N_ZIP_CODE	FEMA Geocoded 5 Digit Zipcode (9 Digit Zipcode in Some Cases)	Almost all records populated; less than 1% null and/or invalid	Location
FLOOD_ZONE	Flood Zone on DFIRM	Almost all records populated; less than 1% null and/or invalid	Risk Rating Factor
POST_FIRM	Is the Parcel Post-FIRM (Yes/No)	Almost all records populated; less than 1% null and/or invalid	Risk Rating Factor
DEDUCT_BLD	Deductible for Building	Almost all records populated; less than 1% null and/or invalid	Premium / Coverage Info
DEDUCT_CON	Deductible for Contents	Approx. 11% of records have null values	Premium / Coverage Info
ELEV_DIFF	Elevation Difference Between Lowest Floor and BFE	No null records but a lot of invalid attributes (ex. elevation differences of ± 1,000 feet)	Elevation
AS_OF_DT	As of Date (Currentness of Policy Database)	All records populated	General Policy Info
ORIG_CONST	Original Construction Date / Substantial	Almost all records populated; less than 1% null and/or invalid	Building Characteristics
BUILDING	Building Number of Floors / Building Type	Almost all records populated; less than 1% null and/or invalid	Building Characteristics
BASEMENT	Type of Basement or Enclosure	Almost all records populated; less than 1% null and/or invalid	Building Characteristics
SMALL_BUS	Small Business Indicator	All records populated	Miscellaneous
CONDO	Indicates If Condo Type	All records populated	Risk Rating Factor
FILE_IND	File Indicator	All records are null	Miscellaneous

TABLE H-2 Continued

Policy Field Name	Policy Feed Description	Comments on Policy Field Values	Data Category
BASE_FLOOD	Base Flood Elevation	All records populated, but approx. 64% had invalid values	Elevation
LOW_FLOOR	Elevation of Lowest Floor	All records populated, but approx. 64% had invalid values	Elevation
ELEV_BLDG	Is the Building Elevated (Yes/No)	All records populated	Building Characteristics
LOC_CONT	Location of Contents	About 30% of records are null	Premium / Coverage Info
INS_VAL_IN	Insurance to Value Indicator	Approx. 58% of records have null values	Premium / Coverage Info
OBSTRUCTIO	Obstruction	Approx. 78% of records have null values	Risk Rating Factor
ELEV_CERT	FEMA Elevation Certificate Indicator	Approx. 58% of records have null values	Elevation
POST_V_CER	Post V Zone Certification Indicator	Approx. 18% of records have null values	Risk Rating Factor
COMM_PROB	Community Probation Surcharge Amount	All records populated	Miscellaneous
CRS_CLASS	Community Rating System Class	All records populated	Risk Rating Factor
CRSE_CONST	Course of Construction Indicator	All records populated; less than 1% null and/or invalid	Building Characteristics
STATE_OWN	State Owned Indicator	Almost all records populated; less than 1% null and/or invalid	Miscellaneous
DIS_ASST	Disaster Assistance Type	All records populated	General Policy Info
FLOOD_PROO	Flood-Proofed Indicator	Almost all records populated; less than 1% null and/or invalid	Building Characteristics
RLTRGTGP_I	Repetitive Loss Target Group Indicator	All records are null	Risk Rating Factor
DIAGRAM_NO	Elevation Certificate Diagram Number	Approx. 53% of records have null values	Elevation

continued

TABLE H-2 Continued

Policy Field Name	Policy Feed Description	Comments on Policy Field Values	Data Category
LOWADJ_GRA	Lowest Adjacent Grade	All records populated, but approx. 69% had invalid values	Elevation
N_PREM_ICC	NFIP Premium ICC Coverage	All records populated	Premium / Coverage Info
N_COV_ICC	NFIP ICC Coverage	All records populated	Premium / Coverage Info
ADDR_UP_DT	Address Update Date	Almost all records populated; less than 1% null and/or invalid	Location
GIS_LONGI	GIS Longitude of Property	Almost all records populated; less than 1% null and/or invalid	Location
GIS_LATI	GIS Latitude of Property	Almost all records populated; less than 1% null and/or invalid	Location
GIS_GEORES	FEMA GIS Geocode Result	All records populated	Location
GIS_GEOCEN	FEMA GIS Geocoded Census Block	Almost all records populated; less than 1% null records but an additional 3% with invalid data	Location
PRINCIPAL	Principal Residence Indicator	All records populated	Risk Rating Factor
BW12	Biggert-Waters 12 Values	All records populated	Risk Rating Factor
CBGFIPS	Census Block Group FIPS (Taken from GIS_ GEOCEN Field)	Almost all records populated; less than 1% null records but an additional 3% with invalid data	Location
STCO_FIPS	State, County FIPS (Taken from GIS_ GEOCEN Field)	Almost all records populated; less than 1% null records but an additional 3% with invalid data	Location

Appendix I

Task Statements for Affordability of National Flood Insurance Program Premiums—Report 1 and Report 2

STATEMENT OF TASK

The Federal Insurance and Mitigation Administration (FIMA) is a component of the Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA), which operates the National Flood Insurance Program (NFIP). On March 21, 2014, President Obama signed the Homeowner Flood Insurance Affordability Act (HFIAA) of 2014 into law. This law repeals and modifies certain provisions of the 2012 Biggert-Waters Flood Insurance Reform Act, and makes additional program changes to other aspects of the program not covered by that Act. One modification regards a study being conducted by the National Research Council (NRC) of the National Academy of Sciences (NAS). HFIAA requires the submission of the Affordability Study by the FEMA Administrator 18 months from enactment of the Act.

FEMA has asked the NAS to provide two reports as part of the NFIP Affordability Study.

The first report, due in February 2015, will discuss the underlying definitions and methods for an affordability framework and describe the affordability concept and applications, and program policy options.

The second report, due in September 2015, will propose alternative approaches for a national evaluation of affordability program policy options, based in part on lessons gleaned from a proof-of-concept pilot study to be guided by the NRC committee.

An ad hoc committee under the auspices of the National Research Council will prepare both reports according to the following statements of task:

First Report

The first report will discuss the underlying definitions for an affordability framework and describe the affordability concept and applications and program policy options.

The first report shall discuss

- Methods for establishing an affordability framework, including means-tested vouchers, for the National Flood Insurance Program;
- Appropriate and necessary assumptions and definitions, including "affordability" and "full risk-based premiums."

Second Report

The second report will propose alternative approaches for a national evaluation of affordability program policy options. The second report will include lessons for the design of a national study from a proof-of-concept pilot study.

The second report shall discuss

- Data issues such as needs, availability, quantity, and quality;
- Appropriate analytical methods and related considerations, including models, computing software, and geographic areas to be analyzed;
- A proof-of-concept pilot analysis to be subcontracted as part of the study. This analysis will apply different methods for conducting a flood insurance affordability analysis for a state (North Carolina) in which data on elevations of structures and hydrologic flood hazards are readily available. This analysis will inform the committee's deliberations and findings regarding the possibilities for a national-level flood insurance affordability study, for which these data on elevations and flood hazards are less readily available;
- National implications from the proof-of-concept pilot results including, but not limited to, possible impacts on participation rates (the analytical work for the proof-of-concept pilot may be carried out by the NRC directly or using subcontractors as necessary).