



Table of Contents

Volume I

SECTION 1. INTRODUCTION 1

1.1 BACKGROUND 1-1

1.1.1 DMA 2000 Origins -The Robert T. Stafford Disaster Relief and
Emergency Assistance Act..... 1-1

1.1.2 Benefits of Mitigation Planning 1-2

1.1.3 Organizations Involved in the Mitigation Planning Effort..... 1-2

1.1.4 Implementation of the Planning Process 1-6

1.1.5 Organization of This Mitigation Plan..... 1-7

SECTION 2. PLAN ADOPTION 2-1

2.1 Overview 2-1

2.1.1 Plan Adoption by Local Governing Bodies..... 2-1

SECTION 3 PLANNING PROCESS 3-1

3.1 INTRODUCTION 3-1

3.2 ORGANIZATION OF PLANNING PROCESS 3-2

3.2.1 Organization of Planning Partnership 3-2

3.2.2 PLANNING ACTIVITIES..... 3-10

3.3 STAKEHOLDER OUTREACH AND INVOLVEMENT 3-13

3.3.1 Federal Agencies:..... 3-13

3.3.2 State Agencies:..... 3-13

3.3.3 County and Regional Agencies, Commissions and Non-Profits:..... 3-14

3.3.4 Regional and Local Stakeholders:..... 3-14

3.3.5 Public Outreach..... 3-17

3.4 INCORPORATION OF EXISTING PLANS, STUDIES, REPORTS AND
TECHNICAL INFORMATION 3-21

3.5 INTEGRATION WITH EXISTING PLANNING MECHANISMS AND
PROGRAMS 3-23

3.6 CONTINUED PUBLIC INVOLVEMENT 3-24

SECTION 4 COUNTY PROFILE 4-1

4.1 GENERAL INFORMATION..... 4-1

4.1.1 Physical Setting..... 4-1

4.2 POPULATION AND DEMOGRAPHICS 4-15

4.3 GENERAL BUILDING STOCK..... 4-21

4.3.1 Development Trends and New Development..... 4-25

4.3.2 Potential Sites for Temporary Housing and Relocation 4-30

4.4 CRITICAL FACILITIES..... 4-31

4.4.1 Essential Facilities..... 4-31

4.4.2 Transportation Systems 4-36

4.4.3 Lifeline Utility Systems 4-40

4.4.4 High-Potential Loss Facilities 4-46

4.4.5 Other Facilities 4-53

SECTION 5. RISK ASSESSMENT 5-1

5.1 Methodology and Tools 5.1-1

5.1.1 Methodology 5.1-1





5.1.2 Tools..... 5.1-1

5.2 Identification of Hazards of Concern..... 5.2-1

5.3 Hazard Ranking 5.3-1

5.3.1 Hazard Ranking Methodology 5.3-1

5.3.2 Hazard Ranking Results 5.3-2

5.3.3 Hazards Profiles and Vulnerability Assessment..... 5.3-6

5.4 Hazard Profiles 5.4-1

5.4.1 Earthquake..... 5.4.1-1

5.4.2 Extreme Temperature 5.4.2-1

5.4.3 Flood 5.4.3-1

5.4.4 Land Failure 5.4.4-1

5.4.5 Severe Storm 5.4.5-1

5.4.6 Severe Winter Storm 5.4.6-1

5.4.7 Wildfire 5.4.7-1

SECTION 6. MITIGATION STRATEGIES6-1

6.1 Background and Past Mitigation Accomplishments.....6-1

6.2 General Mitigation Planning Approach.....6-2

6.3 Mitigation Goals and Objectives6-2

6.3.1 Goals and Objectives.....6-2

6.4 Capability Assessment.....6-3

6.4.1 Summary of Plans, Programs and Resources Available to Support Mitigation6-4

6.4.2 Administrative and Technical Capabilities - Local6-7

6.4.3 Fiscal Capabilities-Federal and State6-11

6.4.4 Fiscal Capabilities – Local6-17

6.5 Mitigation Strategy Development.....6-18

6.5.1 Local Mitigation Strategy Development6-18

6.5.2 County Mitigation Strategy Development.....6-19

6.5.3 Mitigation Strategy Evaluation and Prioritization.....6-19

6.5.4 Benefit/Cost Review6-21

SECTION 7. PLAN MAINTENANCE PROCEDURES7-1

7.1 Monitoring, Evaluating and Updating the Plan.....7-1

7.1.1 Monitoring.....7-2

7.1.2 Evaluating7-2

7.1.3 Updating.....7-4

7.2 Implementation of Mitigation Plan Through Existing Programs7-5

7.3 Continued Public Involvement.....7-7

Acronyms..... AC-1

GlossaryG-1

References..... R-1

Appendices

Appendix A Sample Resolution of Plan Adoption

Appendix B Meeting Documentation

Appendix C Public and Stakeholder Outreach Documentation

Appendix D Participation Matrix

Appendix E Action Worksheet Template and Instructions

Appendix F Plan Review Tools

Appendix G Vulnerability Assessment Results



Volume II

SECTION 8. PLANNING PARTNERSHIP8-1

8.1 Background.....8-1

8.1.1 Jurisdictional Annexes8-1

SECTION 9. JURISDICTIONAL ANNEXES9-1

9.1 Putnam County9.1-1

9.2 Village of Brewster9.2-1

9.3 Town of Carmel9.3-1

9.4 Village of Cold Spring9.4-1

9.5 Town of Kent9.5-1

9.6 Village of Nelsonville9.6-1

9.7 Town of Patterson9.7-1

9.8 Town of Phillipstown9.8-1

9.9 Town of Putnam Valley9.9-1

9.10 Town of Southeast9.10-1



List of Tables

Table 1-1 Participating Putnam County Jurisdictions..... 1-2

Table 1-2 FEMA Local Mitigation Plan Review Crosswalk 1-5

Table 3-1 Participating Putnam County Jurisdictions..... 3-1

Table 3-2 Project Management Team..... 3-3

Table 3-3 Planning Committee Members and other jurisdictional participants (or “Participation Matrix”) 3-5

Table 3-4 Summary of Mitigation Planning Activities / Efforts..... 3-10

Table 3-5 Record Review (Municipalities) - Record of the review of existing programs, policies, and technical documents for participating jurisdictions (all) 3-22

Table 4-1 Land Use Summary for Putnam County, 2006 & 20011..... 4-11

Table 4-2 Putnam County Population Statistics..... 4-15

Table 4-3 Putnam County Population Trends, 1900 to 2013..... 4-19

Table 4-4 Population Trends in Putnam County by Municipality 4-20

Table 4-5 Number of Buildings and Improvement Value by Municipality 4-21

Table 4-6 Number of Buildings and Total Replacement Value by Occupancy Class 4-22

Table 4-7 Known and Anticipated New Development in Putnam County 4-26

Table 4-8 Police Stations in Putnam County 4-31

Table 4-9 Fire Stations and Rescue Squads in Putnam County 4-31

Table 4-10 Emergency Operation Centers in Putnam County 4-32

Table 4-11 Hospital and Medical Facilities in Putnam County 4-33

Table 4-12 Schools in Putnam County 4-33

Table 4-13 Senior Facilities in Putnam County 4-34

Table 4-14 Bus and Other Transit Facilities in Putnam County 4-36

Table 4-15 Railroad Facilities in Putnam County..... 4-37

Table 4-16 Critical Highway Bridges in Putnam County 4-37

Table 4-17 Potable Water Facilities in Putnam County..... 4-40

Table 4-18 Putnam County Wastewater Treatment Facilities and Pump Stations..... 4-41

Table 4-19 Putnam County Natural Gas Facilities 4-43

Table 4-20 Electric Substations and Transfer Facilities in Putnam County..... 4-43

Table 4-21 Communication Facilities in Putnam County..... 4-44

Table 4-22 Dam Hazard Potential Classifications 4-46

Table 4-23 Dams in Putnam County..... 4-48

Table 4-24 Other Facilities in Putnam County 4-55

Table 5.2-1 Identification of Hazards of Concern for Putnam County 5.2-2

Table 5.3-1 Probability of Occurrence Ranking Factors 5.3-1

Table 5.3-2 Numerical Values and Definitions for Impacts on Population, Property and Economy 5.3-1

Table 5.3-3 Probability of Occurrence Ranking for Hazards of Concern for Putnam County 5.3-2

Table 5.3-4 Impact Ranking for Hazards of Concern for Putnam County..... 5.3-4

Table 5.3-5 Total Risk Ranking Value for Hazards of Concern for Putnam County 5.3-5

Table 5.3-6 Summary of Overall Ranking of Natural Hazards by Jurisdiction 5.3-5

Table 5.4.1-1 Richter Scale..... 5.4.1-2

Table 5.4.1-2 Modified Mercalli Intensity Scale 5.4.1-2

Table 5.4.1-3 Modified Mercalli Intensity (MMI) and PGA Equivalents 5.4.1-3

Table 5.4.1-4 NEHRP Soil Classifications 5.4.1-7

Table 5.4.1-5 Earthquake Events Impacting Putnam County, 1950 to 2014..... 5.4.1-19

Table 5.4.1-6 Approximate Population within NEHRP ‘D’ and ‘E’ Soils..... 5.4.1-26



Table 5.4.1-7 Summary of Estimated Sheltering Needs for Putnam County.....5.4.1-26

Table 5.4.1-8 Estimated Number of Injuries and Casualties from the 2,500-Year MRP Earthquake Event.....5.4.1-27

Table 5.4.1-9 Number and Improvement Value of Buildings within NEHRP ‘D’ and ‘E’ Soils.....5.4.1-27

Table 5.4.1-10 Example of Structural Damage State Definitions for a Light Wood-Framed Building..5.4.1-28

Table 5.4.1-11 Estimated Value (Building and Contents) Damaged by the 100-, 500- and 2,500-Year MRP Earthquake Events5.4.1-30

Table 5.4.1-12 Number of Critical Facilities Located in the NEHRP Soil Class D and E5.4.1-32

Table 5.4.1-13 Estimated Damage and Loss of Functionality for Critical Facilities and Utilities in for the 500-Year MRP Earthquake Event.....5.4.1-33

Table 5.4.1-14 Estimated Damage and Loss of Functionality for Critical Facilities and Utilities for the 2,500-Year MRP Earthquake Event5.4.1-33

Table 5.4.1-15 Estimated Debris Generated by the 500- and 2,500-year MRP Earthquake Events.....5.4.1-34

Table 5.4.2-1 Heat Index Chart.....5.4.2-4

Table 5.4.2-2 Adverse Effects of Prolonged Exposures to Heat on Individuals.....5.4.2-4

Table 5.4.2-3 National Weather Service Alerts5.4.2-5

Table 5.4.2-4 Average High and Low Temperature Range for Winter Months in Putnam County5.4.2-7

Table 5.4.2-5 Average High and Low Temperature Range for Summer Months in Putnam County.....5.4.2-7

Table 5.4.2-6 MRCC Temperature Extremes – Putnam County5.4.2-8

Table 5.4.2-7 Extreme Temperature Events between 1950 and 2014.....5.4.2-9

Table 5.4.2-8 USDA Declared Disasters5.4.2-10

Table 5.4.2-9 Occurrences of Extreme Temperature Events in Putnam County, 1950 - 2014.....5.4.2-11

Table 5.4.2-10 Projected Seasonal Precipitation Change in Region 5, 2050s (% change).....5.4.2-11

Table 5.4.3-1 Flooding Events in Putnam County Between 1950 and 20145.4.3-15

Table 5.4.3-2 Projected Seasonal Precipitation Change in Region 5, 2050s (% change).....5.4.3-19

Table 5.4.3-3 Estimated Population Exposed to the Flood Hazard5.4.3-23

Table 5.4.3-4 Total Land Area Located in the Flood Zones (Acres).....5.4.3-24

Table 5.4.3-5 Estimated General Building Stock Exposure to the 1-Percent and 0.2-Percent Annual Chance Flood Events – All Occupancies.....5.4.3-26

Table 5.4.3-6 Estimated General Building Stock Exposure to the 1-Percent and 0.2-Percent Annual Chance Flood Events – Residential Occupancy Class.....5.4.3-27

Table 5.4.3-7 Estimated General Building Stock Exposure to the 1-Percent and 0.2-Percent Annual Chance Flood Events – Commercial Occupancy Class.....5.4.3-28

Table 5.4.3-8 Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event5.4.3-29

Table 5.4.3-9 Occupancy Class of Repetitive Loss Structures in Putnam County5.4.3-30

Table 5.4.3-10 Occupancy Class of Repetitive Loss Structures in Putnam County, by Jurisdiction.....5.4.3-31

Table 5.4.3-11 NFIP Policies, Claims and Repetitive Loss Statistics.....5.4.3-32

Table 5.4.3-12 Number of Critical Facilities Located in the 1-Percent Annual Chance Flood Boundaries.....5.4.3-34

Table 5.4.3-13 Number of Critical Facilities Located in the 0.2-Percent Annual Chance Flood Boundaries.....5.4.3-35

Table 5.4.3-14 Critical Facilities Located in the 1-Percent and 0.2-Percent Annual Chance Flood Boundaries and Estimated Potential Damage.....5.4.3-36

Table 5.4.3-15 Estimated Debris Generated from the 1-Percent Flood Event.....5.4.3-38

Table 5.4.4-1 Land Failure Events in Putnam County.....5.4.4-8

Table 5.4.4-2 Karst Types.....5.4.4-11

Table 5.4.4-3 Population Exposed to Landslide and Karst Areas in Putnam County.....5.4.4-14

Table 5.4.4-4 General Building Stock Exposed to the Land Failure Hazard in Putnam County.....5.4.4-14



Table 5.4.4-5 Number of Critical Facilities in the Landslide Incidence Susceptibility (High) Area in Putnam County5.4.4-15

Table 5.4.4-6 Critical Facilities Located in the Landslide and Karst Hazard Areas5.4.4-15

Table 5.4.5-1 NWS Wind Descriptions 5.4.5-2

Table 5.4.5-2 Hail Size 5.4.5-5

Table 5.4.5-3 Fujita Damage Scale..... 5.4.5-6

Table 5.4.5-4 Enhanced Fujita Damage Scale 5.4.5-7

Table 5.4.5-5 EF Scale Damage Indicators..... 5.4.5-7

Table 5.4.5-6 The Saffir-Simpson Scale 5.4.5-8

Table 5.4.5-7 Wind Zones in the U.S. 5.4.5-16

Table 5.4.5-8 Severe Storm Events between 1950 and 2014..... 5.4.5-25

Table 5.4.5-9 Probability of Occurrence of Severe Storm Events 5.4.5-32

Table 5.4.5-10 Projected Seasonal Precipitation Change in Region 5, 2050s (% change) 5.4.5-33

Table 5.4.5-11 Description of Damage Categories 5.4.5-35

Table 5.4.5-12 Estimated Building Replacement Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Winds for All Occupancy Classes 5.4.5-37

Table 5.4.5-13 Estimated Impacts to Critical Facilities for the 500-Year Mean Return Period Hurricane-Related Winds 5.4.5-38

Table 5.4.5-14 Debris Production (Tons) for 100-Year MRP Wind Event 5.4.5-39

Table 5.4.5-15 Debris Production (Tons) for 500-Year MRP Wind Event 5.4.5-39

Table 5.4.6-1 RSI Ranking Categories 5.4.6-3

Table 5.4.6-2 Winter Storm Events Between 1950 and 2014..... 5.4.6-8

Table 5.4.6-3 Projected Seasonal Precipitation Change in Region 5, 2050s (% change)..... 5.4.6-13

Table 5.4.6-4 General Building Stock Exposure (Structure Only) and Estimated Losses from Severe Winter Storm Events in Putnam County 5.4.6-15

Table 5.4.7-1 Fire Danger Rating and Color Code 5.4.7-4

Table 5.4.7-2 Region 3, Zone B Wildfire Statistics 5.4.7-13

Table 5.4.7-3 Wildfire Events between 1950 and May 2014..... 5.4.7-14

Table 5.4.7-4 Projected Seasonal Precipitation Change in Region 5, 2050s (% change) 5.4.7-16

Table 5.4.7-5 Estimated Population Located within the WUI in Putnam County 5.4.7-18

Table 5.4.7-6 Building Stock Replacement Value Located within the WUI in Putnam County 5.4.7-18

Table 5.4.7-7 Number of Critical Facilities in the WUI (Intermix or Interface) in Putnam County 5.4.7-19

Table 5.4.7-8 Critical Facilities Located in the Wildfire Hazard Areas 5.4.7-20

Table 6-1 Putnam County Hazard Mitigation Plan Goals.....6-3

Table 6-2 Qualitative Cost and Benefit Ratings 6-22

Table 7-1 Planning Committee 7-1

Table 7-2 Incorporation into Existing & Future Planning Mechanisms 7-6

Table 8-1 Participating Putnam County Jurisdictions.....8-1



List of Figures

Figure 1-1 Putnam County, New York Mitigation Plan Area..... 1-4

Figure 1-2 Putnam County Hazard Mitigation Planning Process..... 1-8

Figure 3-1 Putnam County Webpage with Link to HMP Webpage..... 3-18

Figure 3-2 Putnam County HMP Webpage ()..... 3-19

Figure 4-1 Watershed..... 4-2

Figure 4-2 Watersheds of New York State 4-3

Figure 4-3 Lower Hudson Watershed 4-4

Figure 4-4 New York City Watershed 4-8

Figure 4-5 Croton Watershed..... 4-9

Figure 4-6 2011 Land Use Land Cover for Putnam County 4-12

Figure 4-7 New York-Northern New Jersey-Long Island, NY-NJ-PA Metropolitan Statistical Area... 4-14

Figure 4-8 Distribution of General Population for Putnam County, New York 4-16

Figure 4-9 Distribution of Persons over the Age of 65 in Putnam County, New York..... 4-17

Figure 4-10 Distribution of Low-Income Population in Putnam County, New York 4-18

Figure 4-11 Putnam County Population Projections, 2010 to 2040..... 4-20

Figure 4-12 Distribution of Residential Building Stock and Value Density in Putnam County 4-23

Figure 4-13 Distribution of Commercial Building Stock and Exposure Density in Putnam County..... 4-24

Figure 4-14 Emergency Facilities in Putnam County 4-35

Figure 4-15 Transportation Facilities in Putnam County 4-39

Figure 4-16 Utility Lifelines in Putnam County..... 4-45

Figure 4-17 High-Potential Loss Facilities in Putnam County..... 4-47

Figure 4-18 Other Facilities in Putnam County 4-54

Figure 5.4.1-1 Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years (2014)..... 5.4.1-4

Figure 5.4.1-2 NEHRP Soils in New York 5.4.1-6

Figure 5.4.1-3 NEHRP Soils in Putnam County 5.4.1-8

Figure 5.4.1-4 Peak Ground Acceleration Modified Mercalli Scale for a 100-Year MRP Earthquake Event..... 5.4.1-9

Figure 5.4.1-5 Peak Ground Acceleration Modified Mercalli Scale for a 500-Year MRP Earthquake Event..... 5.4.1-10

Figure 5.4.1-6 Peak Ground Acceleration Modified Mercalli Scale for a 2,500-Year MRP Earthquake Event..... 5.4.1-11

Figure 5.4.1-7 Ramapo Fault Line 5.4.1-13

Figure 5.4.1-8 Earthquake Occurrences Near the Ramapo Fault Line..... 5.4.1-14

Figure 5.4.1-9 Stamford-Peekskill Seismic Zone. 5.4.1-15

Figure 5.4.1-10 Lamont-Doherty Seismic Stations Locations in the New York-New Jersey Area..... 5.4.1-16

Figure 5.4.1-11 USGS Seismic Stations near New York State..... 5.4.1-17

Figure 5.4.1-12 Earthquake Epicenters in the Northeast U.S., October 1975 to July 2014 5.4.1-18

Figure 5.4.1-13 NEHRP Soils Types in Putnam County 5.4.1-25

Figure 5.4.2-1 Average Number of Weather Related Fatalities in the U.S..... 5.4.2-2

Figure 5.4.2-2 NWS Wind Chill Index 5.4.2-3

Figure 5.4.2-3 New York State Climate Divisions..... 5.4.2-6

Figure 5.4.3-1 Floodplain..... 5.4.3-2

Figure 5.4.3-2 FEMA Flood Zones for Putnam County 5.4.3-12

Figure 5.4.3-3 Presidential Disaster Declarations for Flooding Events, 1954 to 2013 5.4.3-14

Figure 5.4.3-4 Projected Rainfall and Frequency of Extreme Storms..... 5.4.3-20

Figure 5.4.3-5 NFIP Repetitive Loss Areas 5.4.3-33



Figure 5.4.3-6 Potential New Development and Flood Boundaries.....5.4.3-40

Figure 5.4.4-1 Landslide Susceptibility in New York State.....5.4.4-4

Figure 5.4.4-2 Land Subsidence in the United States5.4.4-5

Figure 5.4.4-3 Mineral Resources in Southeastern New York State.....5.4.4-6

Figure 5.4.4-4 Presidential Disaster Declarations for Flooding Events, 1954 to 20135.4.4-7

Figure 5.4.4-5 Landslide Hazard Areas in Putnam County.....5.4.4-12

Figure 5.4.4-6 Karst Areas in Putnam County5.4.4-13

Figure 5.4.5-1 Hail Formation.....5.4.5-2

Figure 5.4.5-2 Storm Surge.....5.4.5-5

Figure 5.4.5-3 Number of Hurricanes for a 100-year Return Period5.4.5-10

Figure 5.4.5-4 Wind Speeds and Storm Track for the 100-Year Mean Return Period Event in Putnam County5.4.5-12

Figure 5.4.5-5 Wind Speeds and Storm Track for the 500-Year Mean Return Period Event in Putnam County5.4.5-13

Figure 5.4.5-6 Number of Days With Hailstorms Annually in the U.S.5.4.5-14

Figure 5.4.5-7 New York Hail Events by County, 1960 to 2012.....5.4.5-15

Figure 5.4.5-8 Wind Zones in the U.S.5.4.5-16

Figure 5.4.5-9 Annual Average Number of Tornadoes in the U.S., 1991-20105.4.5-17

Figure 5.4.5-10 Historical Tornado Tracks in New York State, 1960-2012.....5.4.5-18

Figure 5.4.5-11 Total Annual Threat of Tornado Events in the U.S., 1980-1999.....5.4.5-19

Figure 5.4.5-12 Annual Average Number of Thunderstorm Days in the U.S.....5.4.5-20

Figure 5.4.5-13 Annual Days Suitable for Thunderstorms/Damaging Winds5.4.5-21

Figure 5.4.5-14 Hurricane Tracks in New York State, 1960 to 2011.....5.4.5-22

Figure 5.4.5-15 Historical North Atlantic Tropical Cyclone Tracks (1842-2012).....5.4.5-23

Figure 5.4.5-16 Projected Rainfall and Frequency of Extreme Storms.....5.4.5-33

Figure 5.4.6-1 Annual Mean Snowfall within the Eastern U.S.....5.4.6-4

Figure 5.4.6-2 Annual Average Snowfall for New York State5.4.6-5

Figure 5.4.6-3 Presidential Disaster Declarations in New York State from Winter Snow Storms and Blizzards (1954 to 2013)5.4.6-7

Figure 5.4.6-1 Wildfire Behavior Triangle5.4.6-2

Figure 5.4.6-2 Forest Ranger Division Wildfire Protection Areas.....5.4.6-7

Figure 5.4.6-3 New York State Fire Danger Rating Areas5.4.6-8

Figure 5.4.6-4 SILVIS Wildland Urban Interface across the United States.....5.4.6-10

Figure 5.4.6-5 SILVIS Wildland Urban Interface and Intermix in Putnam County5.4.6-11

Figure 5.4.6-6 Wildfire Occurrences in New York State, 2000-2012.....5.4.6-12

Figure 5.4.6-7 Potential New Development and the WUI5.4.6-30

Figure 5.4.7-1 Wildfire Behavior Triangle5.4.7-2

Figure 5.4.7-2 Forest Ranger Division Wildfire Protection Areas.....5.4.7-7

Figure 5.4.7-3 New York State Fire Danger Rating Areas5.4.7-8

Figure 5.4.7-4 SILVIS Wildland Urban Interface across the United States.....5.4.7-10

Figure 5.4.7-5 SILVIS Wildland Urban Interface and Intermix in Putnam County5.4.7-11

Figure 5.4.7-6 Wildfire Occurrences in New York State, 2000-2012.....5.4.7-12