igation Ideas

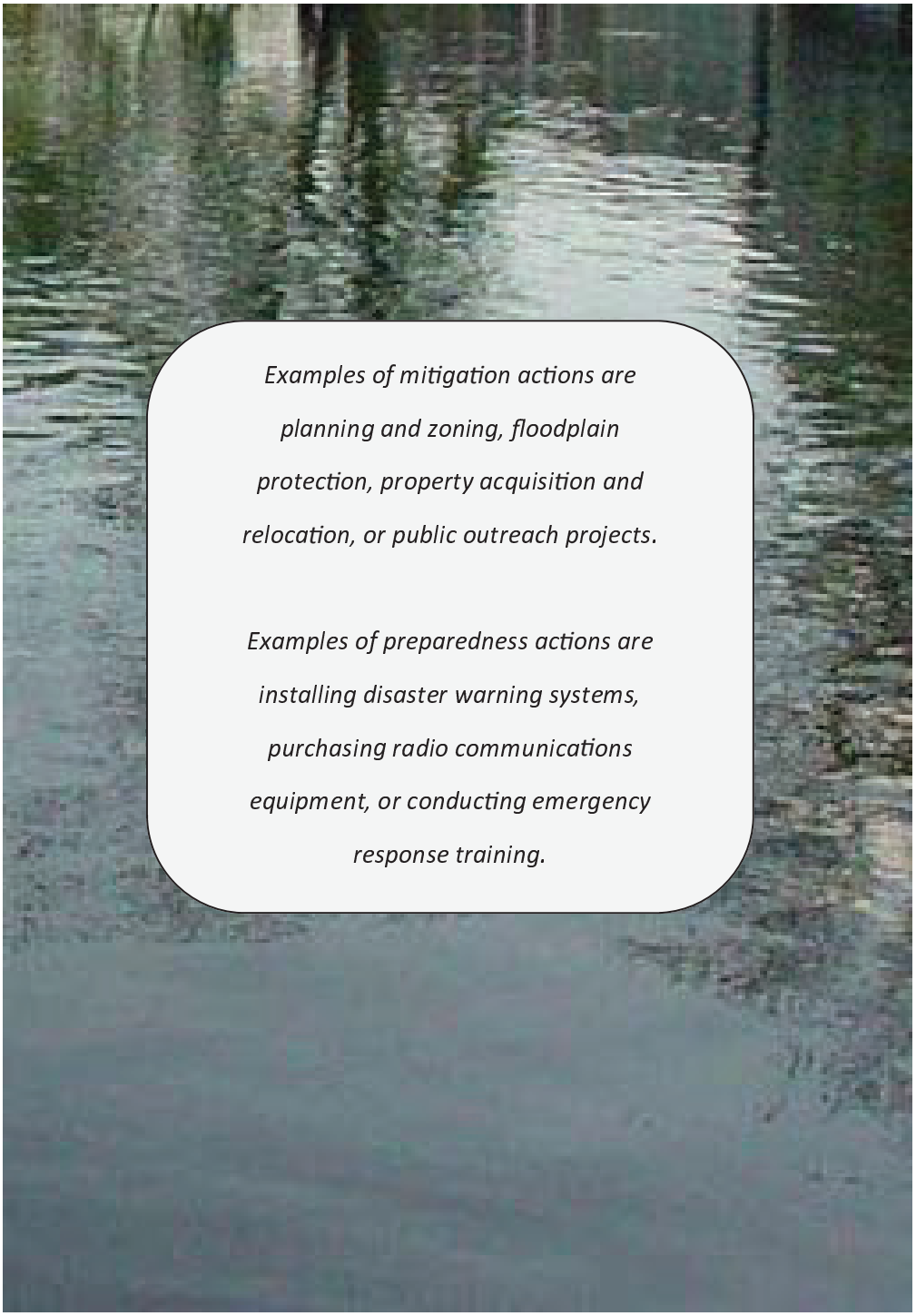
Mitigation Measures by Hazard Type

tion

ent is to provide a resource that
tify and evaluate a range of poten-
ducing risk to natural hazards and

s mitigation, which is action taken
term risk to hazards. Mitigation is
which is action taken to improve
ational preparedness.

o be a starting point for gathering
d as the only source for identifying
seek innovative and different ide-
et their unique needs. The actions
igible for Federal assistance pro-
specific program guidance and
itigation Officer (SHMO) or region-
mation.



Examples of mitigation actions are planning and zoning, floodplain protection, property acquisition and relocation, or public outreach projects.

Examples of preparedness actions are installing disaster warning systems, purchasing radio communications equipment, or conducting emergency response training.

gation Planning Tool for Communities in FEMA Region 1

Table of Contents

What is Mitigation?

y sustained action taken to reduce
k to human life and property from
lowing list of possible hazard miti-
ities is compiled from experience
es of FEMA Region 1: Maine, Ver-
achusetts, Connecticut, and Rhode
es and ideas starts generally with
uch as flood or earthquake. As ex-
t preclude other ideas for activities
or reduce damages in the future.
ped in other FEMA publications, in-
as in publications of other federal

rements for Plan Approval:

tion strategy that 1) analyzes ac-
urisdiction considered to reduce
ed in the risk assessment, and 2)
ojects that the jurisdiction intends

***s** means a hazard mitigation ac-*
ample, adopting a building code) or
example, elevating structures or
re) designed to reduce or eliminate
ds. This sub-element can be met
or a combination of actions and

e non-mitigation actions, such as

actions that are emergency response or operational preparedness in nature. These will not be accepted as hazard mitigation actions, but neither will FEMA require these to be removed from the plan prior to approval.

A comprehensive range consists of different hazard mitigation alternatives that address the vulnerabilities to the hazards that the jurisdiction(s) determine are most important.

b. Each jurisdiction participating in the plan must have mitigation actions specific to that jurisdiction that are based on the community's risk and vulnerabilities, as well as community priorities.

c. The action plan must reduce risk to existing buildings and infrastructure as well as limit any risk to new development and redevelopment. With emphasis on new and existing building and infrastructure means that the action plan includes a consideration of actions that address the built environment.

- Local Mitigation Plan Guidance (p 24)

ater conservation measures during , including:

linance to restrict the use of public water -essential usage, such as landscaping, g swimming pools, etc.

ces to prioritize se, particularly uations like fire-

y and delivery r through ac-

elivery systems drought events. r upgrading ex- ery systems to nd leaks.

olerant land- measures

ught tolerant or s into land- to reduce de- ation.

es for xeriscaping.

driveways and surfaces to reduce runoff ndwater recharge.

rthquake damage to structures. Con-

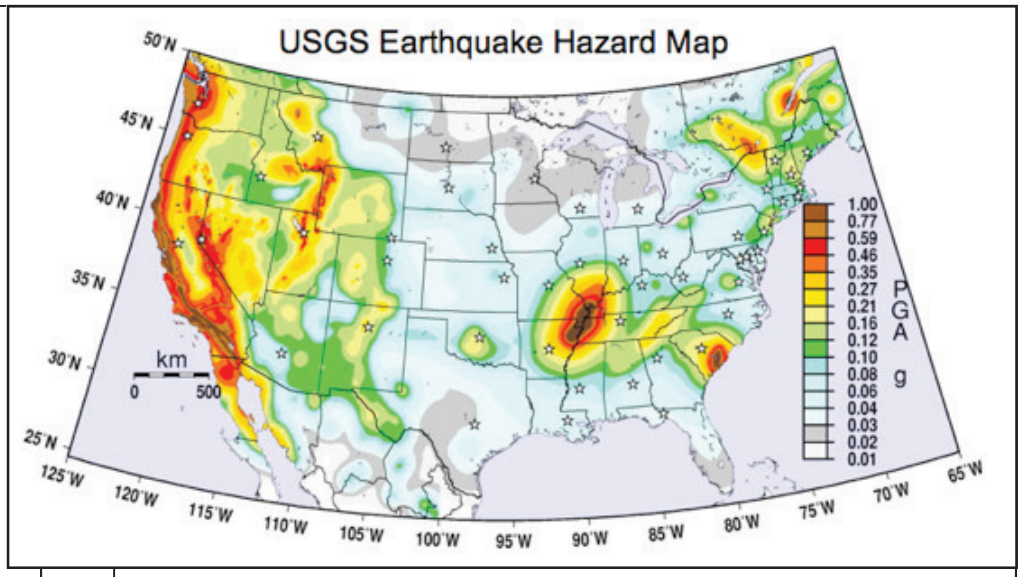
nforcing updated building code provi-
rthquake damage risk.
nforcing the International Building
ernational Residential Code (IRC).

e to critical facilities and infrastructure
ts through actions such as:
c retrofitting for critical public facilities
thquakes.
of generators, elevators, and other
hospitals.
rdening critical lifeline systems (i.e.,
ices such as utilities and roads) to meet
uidelines and Standards for Lifelines" or
rds such as American Lifelines Alliance
his may distinguish a manageable earth-
al and economic catastrophe.
uction plans for all bridges to determine
to collapse and retrofitting problem

ng when extending water, sewer, or natu-

valves and emergency connector hoses
s cross fault lines.

measures to reduce damage from fu-
as:
retrofitting non-reinforced masonry
-ductile concrete facilities that are partic-
o ground shaking.
ng veneers to prevent failure.



- Building a safe room to provide protection during an earthquake.
- Installing window film to prevent injuries from shattered glass.
- Anchoring rooftop-mounted equipment (i.e., HVAC units, satellite dishes, etc).
- Constructing masonry chimneys greater than 6 feet above a roof with continuous reinforced steel bracing.

- **There are many ways to increase awareness of earthquake risk, including:**
  - Working with insurance industry representatives to increase public awareness of the importance of earthquake insurance. Residential structural improvements can be factored into the process of obtaining insurance coverage or reduced deductibles.
  - Developing an outreach program about earthquake risk and mitigation activities in homes, schools, and businesses.

ued

wners on safety techniques to follow dur-
arthquake.
d mapping online for residents and de-
.

earthquake damage can be improved if made aware of proper design and build-ach activities include:
nation sessions or other forms of out-
code provisions for new and existing
nce code use and enforcement by local
ers, contractors, and code enforcement

**rofit existing structures to reduce dam-
Potential actions include the following:**
wners about structural and non-structural
nerable homes and encouraging retrofit.
nical assistance information program for
ching them how to seismically strengthen
e an effective mitigation activity. The
de providing local government building
copies of existing strengthening and re-
or distribution.
treach program to encourage homeown-
shings, storage cabinets, and utilities to
nd damage. Examples include anchoring
file cabinets, installing latches on draw-
ors, restraining desktop computers and
flexible connections on gas and water
amed pictures and mirrors securely, and
cing propane tanks and gas cylinders.

- Establishing a library of technical documents on structural and non-structural mitigation options as well as model ordinances and procedures that have been used by other jurisdictions to reduce earthquake risk.

nitigated by regulating how development uch as the following:

t and erosion control regulations.
nd erosion overlay districts.
sion protection program for high hazard

n control

opment in

nplementing
ement plan.
ory erosion
mes.
nd critical
f areas sus-
n to decrease
disruption.

ure Projects:
uildings and
m erosion
prevent dam-
nd infrastruc-
, consider acquiring and demolishing or
buildings and infrastructure and enforcing
tions on development after land and
on.

otible to erosion, consider options such

n with proper bank stabilization, sloping
ques, planting vegetation on slopes, ter-
racing hillsides, or installing riprap boulders or geotextile fabric.
- Stabilizing cliffs with terracing or plantings of grasses or other plants to hold soil together.
- Prohibiting removal of natural vegetation from dunes and slopes.
- Planting mature trees in the coastal riparian zone to assist in dissipation of the wind force in the breaking wave zone.
- Using a hybrid of hard/soft engineering techniques (i.e., combine low-profile rock, rubble, oyster reefs, or wood structures with vegetative planting or other soft stabilization techniques).
- Implementing marine riparian habitat reinstatement or revegetation.
- Using a rock splash pad to direct runoff and minimize the potential for erosion.
- Using bioengineered bank stabilization techniques.

- **Consider ways to help citizens become more aware of specific erosion risks in your area, such as:**
  - Notifying property owners located in high-risk areas.
  - Disclosing the location of high-risk areas to buyers.
  - Developing a brochure describing risk and potential mitigation techniques.
  - Offering GIS hazard mapping online for residents and design professionals.

res

nd buildings and roads replace open and and vegetation, urban regions become warmer than their rural surroundngs, forming an "island" of heat. Several methods for reducing heat island effects nclude:

- Increasing tree plantings around buildngs to shade parking lots and along public ights-of-way.
- Encouraging installation of green oofs, which provide shade and remove eat from the roof surface and surroundng air.
- Using cool roofing products that reflect sunlight and heat away from a building.

- **Measures should be taken to ensure vulnerable populations are adequately cts of extreme temperatures, such as:**

ch to vulnerable populations, including romoting accessible heating or cooling mmunity.

m temperatures in hous-
s.

y companies to offer spe- for paying heating bills, if ed by state law.

se to track those individu- death, such as the elderly,

- **Extreme cold may cause water pipes to freeze and burst, which can cause flooding inside a building. Ideas for educating property owners include the following:**
  - Educating homeowners and builders on how to protect their pipes, including locating water pipes on the inside of building insulation or keeping them out of attics, crawl spaces, and vulnerable outside walls.
  - Informing homeowners that letting a faucet drip during extreme cold weather can prevent the buildup of excessive pressure in the pipeline and avoid bursting.

and floodplain management can miti-
ing development. Strategies include:
enforcing acceptable land uses to alleviate
e by limiting exposure in flood hazard are-
coastal zone management can be includ-
ive planning.
s during infrastructure planning. For ex-
o extend roads or utilities to an area may
to flood hazards.
isaster recovery ordinance based on a
epair activity, generally depending on

cing an ordinance that regulates dumping
ches.
een infrastructure" program to link, man-
xisting parks, preserves, greenways, etc.
nts for planned and regulated public use
d land for temporary water retention and

d by limiting or restricting how develop-
n areas through actions such as:
ting floodplain development through reg-
entive-based measures.
ty of developments in the floodplain.
odplains be kept as open space.
ntage of allowable impervious surface
parcels.
am buffer ordinance to protect water re-
flood impacts.
in floodplain areas.

- **The use of building codes and development standards can ensure structures are able to withstand flooding. Potential actions include:**
  - Adopting the International Building Code (IBC) and International Residential Code (IRC).
  - Adopting ASCE 24-05 Flood Resistant Design and Construction. ASCE 24 is a referenced standard in the IBC that specifies minimum requirements and expected performance for the design and construction of buildings and structures in the flood hazard areas to make them more resistant to flood loads and flood damage.
  - Adding or increasing "freeboard" requirements (feet above base flood elevation) in the flood damage ordinance.
  - Prohibiting all first floor enclosures below base flood elevation for all structures in flood hazard areas.

tation of new development during design
, buildings, infrastructure, etc.).
flood elevation at or above the historical
f it is above the mapped base flood eleva-

design standards to require elevation da-
g platting and to have buildable space on
e flood elevation.
d tie-downs of propane tanks.

t can cause flooding and erosion in devel-
management practices to prevent this

mwater drainage study for known prob-

- Preparing and adopting a stormwater drainage plan and ordinance.
- Preparing and adopting a community-wide stormwater management master plan.
- Regulating development in upland areas in order to reduce stormwater run-off through a stormwater ordinance.
- Developing engineering guidelines for drainage from new development.
- Requiring a drainage study with new development.

- **In addition to stormwater management, techniques to reduce rain runoff can prevent flooding and erosion, such as:**
  - Designing a “natural runoff” or “zero discharge” policy for stormwater in subdivision design.
  - Requiring more trees be preserved and planted in landscape designs to reduce the amount of stormwater runoff.
  - Requiring developers to plan for on-site sediment retention.
  - Requiring developers to construct on-site retention basins for excessive stormwater and as a firefighting water source.
  - Encouraging the use of porous pavement, vegetative buffers, and islands in large parking areas.
  - Conforming pavement to land contours so as not to provide easier avenues for stormwater.
  - Encouraging the use of permeable driveways and surfaces to reduce runoff and increase groundwater recharge.
  - Adopting erosion and sedimentation control regulations for construction and farming.

ance Program
owners in par-
o purchase in-
st flood losses.
lity and main-

IP.
ces that meet
and state re-
mply with NFIP.
ommunity
vide infor-
tives for proper-
ire flood insur-

l floodplain manager and/or CRS coordi-
es CFM certification.
aintaining FEMA elevation certificates for
post-FIRM buildings.
ntaining FEMA elevation certificates for
ved buildings located in floodplains.

on in NFIP, implementing good flood-
iques that exceed minimum require-
flood losses. Examples include:
ASFPM's "No Adverse Impact" policy into
anagement programs.
plain ordinance to incorporate cumula-
mage requirements.
e" in base flood elevation clause for the
vention ordinance.
eboard requirement past the mapped

floodplain to include an equivalent land elevation.

- Including requirements in the local floodplain ordinance for homeowners to sign non-conversion agreements for areas below base flood elevation.
- Establishing and publicizing a user-friendly, publicly-accessible repository for inquirers to obtain Flood Insurance Rate Maps.
- Developing an educational flyer targeting NFIP policyholders on increased cost of compliance during post-flood damage assessments.
- Annually notifying the owners of repetitive loss properties of Flood Mitigation Assistance funding.
- Offering incentives for building above the required freeboard minimum (code plus).

- **The Community Rating System (CRS) rewards communities that exceed the minimum NFIP requirements. Depending upon the level of participation, flood insurance premium rates are discounted for policyholders. Potential activities that are eligible to receive credit include**:
  - Advising the public about the local flood hazard, flood insurance, and flood protection measures.
  - Enacting and enforcing regulations that exceed NFIP minimum standards so that more flood protection is provided for new development.
  - Implementing damage reduction measures for existing buildings such as acquisition, relocation, retrofitting, and maintenance of drainageways and retention basins.

es from Flood Hazard Areas

remove structures from flood-prone are-
ure flood losses by acquiring and demol-
g structures from voluntary property
rving lands subject to repetitive flooding.
**t can cause flooding and erosion in devel-
ormwater management projects that**

ng, or increasing the capacity of a storm

ge or absorption capacities with detention
ins, relief drains, spillways, drain widen-

ing/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection.

- Increasing capacity of stormwater detention and retention basins.
- Increasing dimensions of drainage culverts in flood-prone areas.
- Using stream restoration to ensure adequate drainage and diversion of stormwater.
- Requiring developers to construct on-site retention basins for excessive stormwater and as a firefighting water source.
- Providing grassy swales along roadsides.

- **Drainage Systems & Flood Control Structures:**
- Implementing an inspection and enforcement program to help ensure continued structural integrity of dams and levees.
- Incorporating ice jam prevention techniques as appropriate.

- **Structures and utilities can be elevated to reduce flood damage, including:**
- Elevating structures so that the lowest floor, including the basement, is raised above the base flood elevation.
- Raising utilities or other mechanical devices above expected flood levels.
- Elevating and anchoring manufactured homes or, preferably, keeping manufactured homes out of the floodplain.

s and water heaters above base flood ele-
ankless water heaters in limited spaces.

s may protect certain structures from

g in a basement, which may be preferable
eep water out completely because it al-
d flooding to balance exterior and interior
scourages structural collapse.
loodproofing of areas above base flood

ant paints or other materials to allow for
floodwater exposure in accessory struc-
e area below an elevated residential

non-residential structures by strengthen-
penings, or using waterproof compounds
on walls to keep water out.

n be implemented to help minimize loss-
flood events, such as:
d bridges above the base flood elevation
cess. In situations where flood waters
ls out, construction, reconstruction, or
not only attention to drainage, but also
moring of vulnerable shoulders or em-

ridges.
stewater treatment facilities located in
s.
ter treatment facilities located in flood

nfrastructure capabilities, using check

valves, sump pumps, and backflow prevention devices in homes and other buildings.
- Using bioengineered bank stabilization techniques.

- **Techniques to protect critical facilities from flood events include:**
  - Requiring that all critical facilities including emergency operations centers (EOC), police stations, and fire department facilities be located outside of flood-prone areas.
  - Requiring all critical facilities to meet requirements of Executive Order 11988 and be built 1 foot above the 500 -year flood elevation.
  - Installing/upgrading stormwater pumping stations.
  - Raising electrical components of sewage lift stations above base flood elevation.
  - Raising manhole openings using concrete pillars.
  - Installing watertight covers or inflow guards on sewer manholes.
  - Installing flood telemetry systems in sewage lift stations.

enerators for pumping and lift stations in san-
along with other measures (e.g., alarms, me-
ls, and switchgear upgrades).
kes around flood-threatened critical facilities.
d bank stabilization techniques.

es can be built to prevent flood damage.

ral projects that are smaller and more local-
s or small berms) in areas that cannot be miti-
structural activities or where structural activi-
due to low densities.
hardened materials placed atop existing
s) to protect against floods.
d bank stabilization techniques.

loodplain protection, riparian buffers, and
hat mitigate flooding. It is important to pre-
h the following:
ancing landforms that serve as natural mitiga-
verbanks, wetlands, dunes, etc.).
anagement, such as vegetative buffers,
l water sources.
erving wetlands to help prevent flooding in

naging riparian buffers along rivers and

egetative beds in stormwater channels.
etative cover on public lands flanking rivers.

d vegetation benefits natural resources
tial flood losses. Techniques include:
space acquisition, reuse, and preservation
rd areas.
anking program for the preservation of the
ial functions of flood hazard areas.

- Using transfer of development rights to allow a developer to increase densities on another parcel that is not at risk in return for keeping floodplain areas vacant.
- Compensating an owner for partial rights, such as easement or development rights, to prevent a property from being developed.

- **Ideas for increasing flood risk awareness include the following:**
  - Encouraging homeowners to purchase flood insurance by the distribution of NFIP information publications.
  - Establishing a Program for Public Information (PPI) with a PPI committee (as suggested by Activity 332 of the CRS Coordinator's Manual).

- **Educate property owners regarding options for mitigating their properties from flooding through outreach activities such as:**
  - Educating the public about securing debris, propane tanks, yard items, or stored objects that may otherwise be swept away, damaged, or pose a hazard if picked up and washed away by floodwaters.
  - Educating homeowners about installing backflow valves to prevent reverse-flow flood damages.
  - Using outreach activities to facilitate technical assistance programs that address measures that citizens can take or facilitate funding for mitigation measures.

* NOTE: For each of the three measures above, public education publications are available from FEMA at no cost.

ns inside or directly adjacent to houses
njuries that may occur when taking shel-
derstorm.

well as retrofitting existing buildings,
ail damage include:
es such as structural bracing, shutters,
window panes, and hail-resistant roof
ng in building design to minimize dam-

eathing to prevent hail penetration.
stant roofing and siding.

ng on specific landslide risks in the com-

ere riparian landslides may occur.
entory of locations where critical facili-
gs, and infrastructure are vulnerable to

ify and map landslide hazard areas.
aintaining a database to track community
ndslides.
ion in wildfire-prone areas to prevent
es (e.g., encourage plants with strong

igated by regulating development in
rough actions such as:
pe/high-risk areas in land use and com-
and creating guidelines or restricting new
ose areas.
sing setback limits on parcels near high-

utside of landslide areas to decrease the
uption.
ting industrial activity that would strip
l top soil.
nomic development activity restrictions in

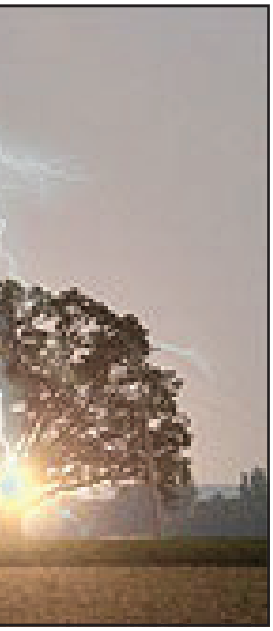
nage and traffic disruptions from land-
uch as:
nitoring mechanisms/procedures (i.e.,
r electronic monitoring systems).
lization measures, such as planting soil-
ion on steep, publicly-owned slopes.

- Using debris-flow measures that may reduce damage in sloping areas, such as stabilization, energy dissipation, and flow control measures.
- Establishing setback requirements and using large setbacks when building roads near slopes of marginal stability.
- Installing catch-fall nets for rocks at steep slopes near roadways.

- **To help mitigate landslide hazards, communities can acquire and demolish or relocate at-risk buildings and infrastructure and enforce permanent restrictions on development after land and structure acquisition.**

nd infrastructure from lighting damage
ures:

protection devices and methods, such as
grounding, on communications infra-
er critical facilities.
ntaining surge protection on critical elec-



d assess local vulnerability to sea level h as:

"what-if" scenarios to estimate potential order to develop sea level rise mitigation

hazard areas, at-risk structures, and asso- g., flood and storm surge) to assess high-

entory of public buildings and infrastruc- particularly vulnerable to sea level rise.

ditions hydrology and areas that may be level rise to Digital Flood Insurance Rate

itigate future losses resulting from sea evelopment in potential hazard areas g, including:

division regulations, and/or a special sea district to designate high-risk areas and ions for the use and development of spe-

management of open space, wetlands, se boundary zones to separate developed azard areas.

development of areas destroyed by erosion in order to prevent future losses.

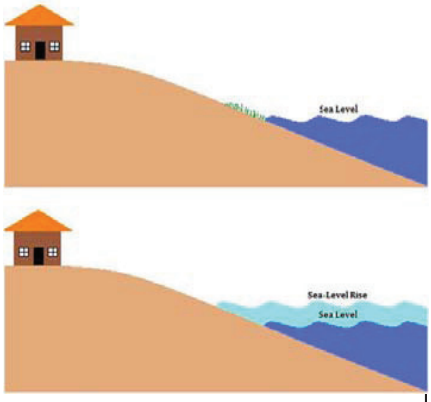
cks in high-risk areas that account for po- se.

be protected from damage resulting gh the following:

for annexation and service extensions in

- Locating utilities and critical facilities outside of areas susceptible to sea level rise to decrease the risk of service disruption.
- Requiring all critical facilities to be built 1 foot above the 500-year flood elevation (considering wave action) or the predicted sea level rise level, whichever is higher.

- **Existing structures, infrastructure, and critical facilities can be protected from sea level rise through the following:**



  - Acquiring and demolishing or relocating structures located in high-risk areas.
  - Retrofitting structures to elevate them above potential sea level rise levels.
  - Retrofitting critical facilities to be 1 foot above the 500-year flood elevation (considering wave action) or the predicted sea level rise level, whichever is higher.
  - Replacing exterior building components with more hazard-resistant materials.
- **Preserve open space to benefit natural resources and to reduce risk to structures from potential sea level rise. Techniques include:**
  - Developing an open space acquisition, reuse, and preservation plan targeting hazard areas.
  - Developing a land banking program for the preservation and management of the natural and beneficial functions of flood hazard areas.
  - Adopting rolling easements along the shoreline to promote natural migration of shorelines.

tinued

development rights to allow a developer
ies on another parcel that is not at risk in
floodplain areas vacant.
owner for partial rights, such as ease-
nent rights, to prevent a property from

e floodplain protection, riparian buffers,
vices that mitigate sea level rise. It is im-
functionality with the following:
propriate use of beach nourishment, sand
p plugs, etc., for coastal hazards.
e restoration, plantings (e.g., sea oats),
materials.
propriate use of sediment-trapping vege-
nounds, etc., for coastal hazards.
-trapping vegetation to buffer the coast
rms by collecting sediment in protective
unes or barrier islands.
craping—using bulldozers to deposit the
bove the high-tide line—to reinforce the
ding new sand.

ounds to act as artificial dunes or plugs
aps in order to slow the inland progress
vind and water.

ss of risks due to sea level rise through
as:
eowners to purchase flood insurance by
cations available to the public. These
e obtained from FEMA at no cost.
ograms to facilitate technical assistance
dress measures that citizens can take or

facilitate funding for mitigation measures.
- Offering GIS hazard mapping online for residents and design professionals.
- Disclosing the location of possible sea level rise areas to potential buyers.

Other sea level rise-related mitigation actions may also apply to other hazards. See the sections entitled "Flood," "Storm Surge," "Erosion," and "Multiple Hazards" for other possible ideas.

Climate change is likely to exacerbate the effects of other hazards as well. See the other sections for possible ideas.

*** Please note that action marked in *italic red font* above may require an Environmental Impact Review prior to initiation.**

g residential construction to prevent wind
opriate regulations are:
ational Building Code (IBC) and International
C).
from International Code Council (ICC)-600
ntial Construction in High-Wind Regions.
codes and structural policies to ensure they
tect older structures from wind damage.
neering measures and construction tech-

f special interlocking shingles designed to
uplift forces in extreme wind conditions to

reduce damage to a roof or other structures.

- Improving nailing patterns.
- Requiring building foundation design, braced elevated platforms, and protections against the lateral forces of winds and waves.
- Requiring new masonry chimneys greater than 6 feet above a roof to have continuous reinforced steel bracing.
- Requiring structures on temporary foundations to be securely anchored to permanent foundations.

- **Promote or Require Site and Building Design Standards to Minimize Wind Damage. Damage associated with severe wind events can be reduced or prevented if considered during building and site design. Examples include the following:**
- Using natural environmental features as wind buffers in site design.
- Incorporating passive ventilation in the building design.
- Incorporating passive ventilation in the site design. Passive ventilation systems use a series of vents in exterior walls or at exterior windows to allow outdoor air to enter the home in a controlled way.
- Encouraging architectural designs that limit potential for wind-borne debris.
- Improving architectural design standards for optimal wind

esistant roof shapes (e.g., hip over gable).

nd and assess local vulnerability to severe as:
ntaining a database to track community vul- wind.
eas that are at risk to the wind hazard associ- hurricane conditions (e.g., Category 1, 2, 3, concentrations of at-risk structures.
ind scenario to estimate potential loss of life es of potential damage, and existing vulnera- mmunity to develop severe wind mitigation

ntitatively estimate potential losses from hur-

frastructure
to provide uninterrupted power after severe both maintenance and repair issues.
d utility lines (e.g., adjust utility pole sizes, dths, and/or line strength).
ure mode for power line design to allow lines l sections rather than as a complete system toration.
cies and loop-feeds.

ifications or retrofits to existing residential e wind damage:
ing envelope.
shutters or other protective measures.
nd walls to eliminate wall failures in high

on-ductile infrastructure with ductile infra- their exposure to hazardous events.
gs with load-path connectors to strengthen es.

- Installing safe rooms.
- Reinforcing garage doors.
- Inspecting and retrofitting roofs to adequate standards to provide wind resistance.

- **Public buildings and critical facilities can be retrofitted to reduce future wind damage with the following actions:**
  - Improving roof coverings (e.g., no pebbles, remove ballast roof systems).
  - Anchoring roof-mounted heating, ventilation, and air conditioning units.
  - Retrofitting buildings with load-path connectors to strengthen the structural frames.
  - Retrofitting or constructing the emergency operations center to FEMA 361 standards.
  - Avoiding placing flag poles or antennas near buildings.
  - Upgrading and maintaining existing lightning protection systems to prevent roof cover damage.
  - Requiring upgrading of reused buildings that will house critical facilities.
  - Protecting traffic lights and other traffic controls from high winds.
  - Converting traffic lights to mast arms.

- **Improve public awareness of severe wind through outreach activities such as:**
  - Educating homeowners on the benefits of wind retrofits such as shutters, hurricane clips, etc.
  - Instructing property owners on how to properly install temporary window coverings before a storm.
  - Educating design professionals to include wind mitigation during building design.

Other severe wind-related mitigation actions may also apply to other hazards. See the sections entitled "Multiple Hazards" and "Tornadoes" for other possible ideas.

her

ure can be protected from the impacts of ollowing regulations:

rnational Building Code (IBC) and Interna- Code (IRC).

lopment and enforcement of building w loads.

ure can be pro- of winter storms ques:

sulation to walls

odified, using create or in- tability.

buildings to withstand snow loads and pse.

cted from the impacts of ollowing techniques:

ards for all utilities re- ng around lines.

power lines.

ilure mode for power line es to fall or fail in small an as a complete system estoration.

ncies and loop-feeds.

th during winter storms is from automo- ion accidents, so it is important to con- lway impacts. Potential strategies in-

- ***Using snow fences or "living snow fences"** (e.g., rows of trees or other vegetation) to limit blowing and drifting of snow over critical roadway segments.
- Installing roadway heating technology to prevent ice/snow buildup.

*If not permanent, this is not *mitigation*. BUT permanent snow fences MAY require environmental reviews.

- **Public awareness of severe winter storms can be improved through the following efforts:**
  - Educating homeowners of the importance of installing carbon monoxide monitors and alarms.
- Educating citizens that all fuel-burning equipment should be vented to the outside.

- **Protect vulnerable populations from the impacts of severe winter storms through the following efforts:**
  - Step One: Identifying specific at-risk populations that may be exceptionally vulnerable in the event of long-term power outages.
  - Step Two: Organizing outreach to vulnerable populations, including establishing and promoting accessible heating centers in the community.

Other winter weather-related mitigation actions may also apply to other hazards. See the sections entitled "Extreme Temperatures" and "Multiple Hazards" for other possible ideas.

ɔment standards can be established to miti-
Possible regulations include:
ational Building Code (IBC) and International
C).
05 Flood Resistant Design and Construction.
the American Society of Civil Engineers, is a
d in the IBC that specifies minimum require-
d performance for the design and construc-
d structures in flood hazard areas to make
t to flood loads and flood damage.
standards for buildings located in areas sus-
rge.
ne construction requirements for new devel-
oastal A-zones.
equirements for higher elevation in inunda-

ndations (e.g., piles or piers) in coastal areas.
ndations in order to avoid erosion and scour.

ed and regulated to minimize the impact of
ures to implement include:
ntaining a beach management plan.

- Adopting shoreline setback regulations and establishing coastal setback lines.
- Adopting coastal zone management regulations.
- Eliminating all obstructions in areas along the coast subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves (also known as the V-zone).
- Limiting or prohibiting development in areas along the coast subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves (referred to as the V-zone on Flood Insurance Rate Maps).
- Adopting coastal A-zones, areas of special flood hazard that extend inland and are subject to breaking waves between 1.5 and 3 feet, and ensuring that they are mapped accurately.
- Adopting and enforcing coastal A-zones in A-zones.

- **Infrastructure and critical facilities can be protected from storm surge damage through the following:**
  - Locating future critical facilities outside of areas susceptible to storm surge.
  - Requiring that all critical facilities meet requirements of Executive Order 11988 and be built 1 foot above the 500-year flood elevation (considering wave action).

- **Map and Assess Vulnerability to Storm Surge. Storm surge risk can be better assessed and monitored with mapping techniques, including the following:**
  - Using GIS to map areas that are at risk to inundation by storm surge.
  - Developing and maintaining a database to track community vulnerability to storm surge.

- **Structural controls can be used to lessen the impact of storm surge. Examples include the following:**
  - Constructing groins to capture material along the shoreline in

etain sand.
sand tubes to trap sand or protect beach-

erm to absorb waves and protect the shore-

rm to keep rock protection in place and pro-
f sediment to the coastal system.

acilities can be protected from damage by llowing:
ore roads so they are parallel (not perpendic-
o prevent the channelization of storm surge

lls or other structures to protect critical facili-
shoreline.
vulnerable critical facilities outside of high-

l Buffers. Natural resources provide flood-uffers, and other ecosystem services that

mitigate storm surge risk. It is important to preserve such functionality with the following:

- Implementing dune restoration, plantings (e.g., sea oats), and use of natural materials.
- Planting sediment-trapping vegetation to make the coast more resistant to coastal storms by collecting sediment in protective features such as dunes or barrier islands.
- ***Performing sand scraping**—using bulldozers to deposit the top foot of sand above the high-tide line—to reinforce the beach without adding new sand.
- Using sediment mounts to act as artificial dunes or plugs for natural dune gaps in order to slow the inland progress of storm-related wind and water.

- **Provide Information on High-Risk Areas. Increase public awareness of storm surge risk through the following actions:**
  - Offering GIS hazard mapping online for residents and design professionals.
  - More accurately mapping problem areas to educate residents about unanticipated risks. Upgrading maps provides a truer measure of risks to a community.
  - Educating property owners in high-risk areas about mitigation options.

- **Illegal in some states – or may require an EIR**

Other storm surge-related mitigation actions may also apply to other hazards. See the sections entitled "Flood" and "Multiple Hazards" for other possible ideas.

pility to Subsidence. Some areas with be fully identified in your community.

areas that are susceptible to subsidence. apping old mining areas or geologically o that development can be prevented or

etrating radar to detect lava tubes and .

ng efforts to identify areas of existing per-

cy of hazard area maps to educate resi- ticipated risks. Upgrading maps provides f risks to a community.

- **Manage Development in High-Risk Areas. Development regulations should consider areas with poor soil conditions, including the following:**
  - Prohibiting development in areas that have been identified as at-risk to subsidence.
  - Restricting development in areas with soil that is considered poor or unsuitable for development.

- **Consider Subsidence in Building Design. If subsidence is considered during building design, future damage may be prevented. Potential actions include:**
  - Educating design professionals about where to locate information on subsidence rates and maps.
  - Incorporating structural designs that can resist loading associated with subsidence.
  - Adopting an ordinance promoting permafrost sensitive construction practices.
  - Including potential subsidence in freeboard calculations for buildings in flood-prone areas.

- **Monitor Subsidence Risk Factors. Several risk factors can be monitored to help predict subsidence, such as the following:**
  - Monitoring areas at risk to subsidence by remaining aware of changes in groundwater levels.
  - Monitoring areas where natural resources are removed from underground.
  - Filling or buttressing subterranean open spaces, as with abandoned mines, to prevent or alleviate collapse.

- **Remove Existing Structures from Subsidence Hazard Areas.**
  - To prevent property loss, acquire and demolish or relocate buildings and infrastructure in high-risk areas.

ued

Subsidence. Increase residents'
e through the following:
unity awareness of subsidence risks and

d mapping online for residents and de-

igation actions may also apply to other
itled "Landslide," "Erosion," and "Multiple
leas.

n and use of safe rooms by:

ction of safe rooms in new schools, day-
homes.

lic about the construction and use of safe
nd shelter areas of manufactured home
, shopping malls, or other vulnerable

ers and homeowners to locate tornado
or directly adjacent to houses to prevent
ng debris or hail (by use of public infor-

grant program to assist homeowners
ruct a new safe room.

-320 - Taking Shelter From the Storm:
r Home or Small Business and Interna-
Standard for the Design and Construction

g measures and construction techniques
owing:

act-resistant glass
rian and garage doors

sive sealing strips
hingles
selection of building materials so that
terials are more readily available to the
idance from ICC-600 Standard for Resi-
on in High-Wind Regions.

Other tornado wind-related mitigation actions may also apply to other hazards. See the sections entitled "Severe Wind" and "Multiple Hazards" for other possible ideas.

pility to Tsunami. Tsunami risk can be itored with mapping techniques, includ-

areas that are vulnerable to inundation by

aintaining a database to track community unamis.

d mapping online for residents and de-

ers on the appropriate uses and limita-

napping problem areas to educate resi-ticipated risks. Upgrading maps provides f risks to a community.

- **Manage Development in Tsunami Hazard Areas. Planning and regulations can mitigate tsunami damage in many ways, such as:**
  - Adopting and enforcing building codes and design standards that contain requirements for tsunami-resistant design.
  - Limiting new development in tsunami run-up areas.

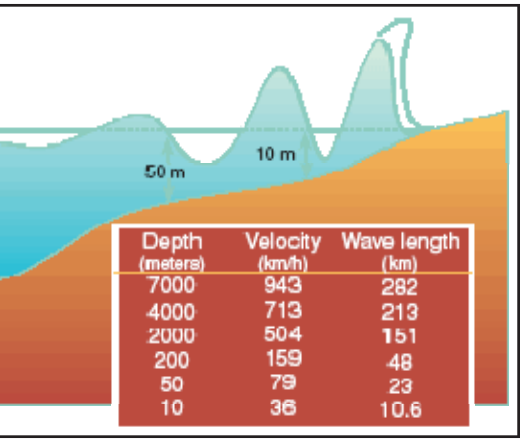
- **Protect Against Fire Following Tsunami. Communities can encourage wildfire mitigation measures (i.e., tree breaks) in tsunami-prone areas to reduce impacts of fires that may occur after a tsunami hits the coastline.**

- **Protect Buildings and Infrastructure. Ensure buildings and infrastructure are adequately protected from tsunami inundation with the following:**
  - Requiring coastal structures to be built to standards that allow for proper vertical evacuation and to be specially designed and constructed to resist both tsunami and earthquake loads.
  - Locating new and relocating existing infrastructure and critical facilities outside of the tsunami hazard area.
  - Elevating existing buildings above the inundation level.
  - Relocating fire-prone infrastructure such as electrical lines or case tanks.

ss of Tsunami Hazard.

mi inundation zones and marking evacua-

showing possible tsunami inundation are-
evelopers away from high-risk areas.
DAA's TsunamiReady Community pro-



n actions may also apply to other hazards.
," "Storm Surge" and "Multiple Hazards" for

d Use Planning. Local governments can regulating development in wildfire haz-se planning, including:

- or a special wildfire overlay district to k areas and specify the conditions for the ent of specific areas.
- and quantity of development, as well , landscaping and water supply.
- pen space or wildland-urban boundary developed areas from high-hazard areas.
- for annexation and service extensions in

- **Develop a Wildland- Urban Interface Code. Communities can develop regulations for safer construction and incorporate mitigation considerations into the permitting process. Potential actions include:**
  - Developing specific design guidelines and development review procedures for new construction, replacement, relocation, and substantial improvement in wildfire hazard areas.
  - Addressing fire mitigation through access, signage, fire hydrants, water availability, vegetation management, and special building construction standards.
  - Involving fire protection agencies in determining guidelines and standards and in development and site plan review procedures.
  - Establishing wildfire mitigation planning requirements for large scale developments or planned unit developments.

- **Retrofit At-Risk Structures with Ignition-Resistant Materials. Existing structures in wildfire hazard areas can be protected through the use of non-combustible materials and technologies, including:**
  - Installing roof coverings, sheathing, flashing, skylights, roof and attic vents, eaves, and gutters that conform to ignition-resistant construction standards.
  - Installing wall components that conform to ignition-resistant construction standards.
  - Protecting propane tanks or other external fuel sources.
  - Purchasing and installing external, structure-specific water hydration systems (sprinklers); dedicated power sources; and dedicated cisterns if no water source (e.g., lake, river, or swimming pool) is available.

Around Structures and Infrastructure.
mplement defensible space programs to
and infrastructure, including:
round residential and non-residential
n the removal or reduction of flammable
ing vertical clearance of tree branches.
ble vegetation with less flammable spe-

e zones around power lines, oil and gas
frastructure systems.

gement Program. A fuels management
ented to reduce hazardous vegetative
ar essential infrastructure, or on private
ndowners. The program can include the

burning to reduce fuel loads that threaten
property.
earing fuel loads created by downed trees.
into public wooded areas in the wildland-

slash and clean-up days" to reduce fuel
ldland-urban interface.
etation management plan.

ogram. The Firewise program provides a
dual residents and their neighbors can
s and neighborhoods safer from fire. Con-

ise Communities/USA" recognition pro-
y the National Wildlife Coordinating
g).
e guidance and requiring best practices

in your community.

- **Educate Property Owners about Wildfire Mitigation Techniques. Educate property owners on actions that they can take to reduce risk to property, such as the following:**
  - Installing fire mitigation systems such as interior and exterior sprinkler systems.
  - Performing safe disposal of yard and household waste rather than
  - open burning.
  - Removing dead or dry leaves, needles, twigs, and combustibles from roofs, decks, eaves, porches, and yards.
  - Creating a defensible space or buffer zone cleared of combustible materials around property.
  - Installing and maintaining smoke detectors and fire extinguishers on each floor of their homes or other buildings.
  - Safely using and storing necessary flammable materials, including machine fuels. Approved safety cans should be used for storing gasoline, oily rags, and other flammable materials. Firewood should be stacked at least 100 feet away and uphill from homes.
  - Keeping flammables, such as curtains, secured away from windows or using heavy fire-resistant drapes.

azard Areas. Limit or prohibit development gh the following types of actions:

- d title in the name of a local governing body es and enforce permanent restrictions on de-
- easements (e.g., conservation) to prevent own hazard areas.
- easements to protect environmentally signifi-cels from development.
- s areas for conservation or restoring as func-
- for public facilities (e.g., schools, police/fire
- ilities for persons with special needs/mobility areas.
- helters in known hazard areas.

ations in Hazard Areas. Regulate develop-nples include:

- nd development regulations to regulate de-d-prone areas.
- from delineated hazard areas (e.g., shore-ep slopes, etc.).
- al/special use permits for the development of known hazard areas.
- Offering expanded development rights to developers/ businesses for performing mitigation retrofits.
- Incorporating restrictive covenants on properties located in known hazard areas.
- Designating high-risk zones as special assessment districts (to fund necessary hazard mitigation projects).

- **Limit Density in Hazard Areas. Limit the density of development in the hazard areas through the following techniques:**
  - Increasing minimum lot size for development in known hazard areas.
  - Designating "agricultural use districts" in the zoning ordinance to limit densities in known hazard areas.
  - Ensuring the zoning ordinance encourages higher densities only outside of known hazards areas.
  - Requiring clustering for planned unit developments (PUD) in the zoning ordinance to reduce densities in known hazard areas.
  - Establishing a local transfer of development rights (TDR) program for risk in known hazard areas.
  - Establishing a process to use floating zones to reduce densities in damaged areas following a disaster event.

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air activity,
g on prop-

ental review standards.
er species selection, planting, and mainte-
o landscape ordinances.

g Codes. Building codes and inspections help
ately withstand damage during hazard
clude:
ational Building Code (IBC) and International
C).
Building Code Effectiveness Grading Schedule
on through higher building code standards
ractices.
r standards for hazard resistance in local ap-
ding code.
tion of new development during design (e.g.,
ngs, infrastructure, etc.)

- Requiring standard tie-downs of propane tanks.
- Requiring tie-downs for all manufactured housing.
- Establishing moratorium procedures to guide the suspension of post-disaster reconstruction permits.
- Revising fire codes to limit hotel room occupancy to ensure timely evacuation of high-use and multi-floor structures.
- Establishing "value-added" incentives for hazard-resistant construction practices beyond code requirements.

- **Create Local Funding Mechanisms for Hazard Mitigation. Local funding resources can be developed through the following measures:**
  - Establishing a local reserve fund for public mitigation measures.
  - Using impact fees to help fund public hazard mitigation projects related to land development (i.e., increased runoff).
  - Requiring a development impact tax on new construction to mitigate the impacts of that development.
  - Recruiting local financial institutions to participate in "good neighbor" lending for private mitigation practices.
  - Providing local match to Federal funds that can fund private mitigation practices.
- **Incentivize Hazard Mitigation. Incentives and disincentives can be used to promote hazard mitigation through the following measures:**
  - Using special tax assessments to discourage builders from constructing in hazardous areas.
  - Using insurance incentives and disincentives (i.e., incentives for best practices).
  - Providing tax incentives for development of low-risk hazard parcels and to encourage infill development.

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fees for home construction projects related

ts, public subsidies, and other incentives to
nitigation practices.
ng the tax burden for undeveloped hazard
pment pressure.
e to structures can be prevented through

ing structures located in hazard areas.
structures to a less hazardous location.
itting public buildings located in high-hazard

itting endangered public housing units in high

police stations to become hazard resistant.
ngthening facilities to function as public shel-

- **Protect Infrastructure and Critical Facilities. Infrastructure and critical facilities can be protected from damage by the following:**
  - Incorporating hazard mitigation principles into all aspects of public-funded building.
  - Incorporating mitigation retrofits for public facilities into the annual capital improvements program.
  - Engineering or retrofitting roads and bridges to withstand hazards.
  - Relocating or undergrounding electrical infrastructure.
  - Designing and building water tanks or wells for use in times of water outage.
  - Installing quick-connect emergency generator hook-ups for critical facilities

- **Promote Private Mitigation Efforts. Encourage private mitigation efforts that address multiple hazards through the following:**
  - Using outreach programs to: 1) advise homeowners of risks to life, health, and safety; 2) facilitate technical assistance programs that address measures that citizens can take; or 3) facilitate funding for mitigation measures.
  - Establishing, maintaining, and publicizing a library section on hazard mitigation techniques for local residents.
  - Identifying and recruiting civic groups and volunteer agencies for community mitigation projects.
  - Establishing a network for a business-to-business mitigation mentoring program.
  - Offering hazard susceptibility audits of local small businesses.
  - Completing a "demonstration model" showing use of hazard mitigation techniques for public display.
  - Establishing a technical assistance program for residents to access data or resources for mitigation purposes.
  - Educating the public on tradeoffs associated with multi-hazard design.