
Hazard Mitigation Planning: Tools and Techniques

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I. Structural Measures

A. Alteration of environment

1. Sediment-trapping Structures

a. Groins: Groins are wall-like structures, built of timber, concrete, metal sheet piling or rock, placed perpendicular to the beach to capture material drifting along the shoreline. A groin's effectiveness in trapping sediment is primarily a factor of the length and the spacing of the groin system. The appropriate length for an effective groin depends on the dominate sediment size: shorter groins for larger grain sizes and longer groin for smaller grain size. The spacing between groins must balance being large enough to not undermine the updrift groin and being small enough to effective act as a sediment trap.

b. Jetties: Jetties are wall-like structures built perpendicular to the coast to stabilize channels, inlets and outlets. While the primary function of jetties is to protect navigation channels, jetties capture sediments by restricting the movement of materials transported by longshore currents. The critical factors for channel stabilization are the width of the channel and management of sediment. Width of the channel must balance being wide enough to reduce current velocity within the channel but narrow enough to restrict shoaling. Likewise, consideration of the sediment economy plays a vital role in the long-term viability of the channel, inlet or outlet.

2. Sediment-moving Structures

a. Beach nourishment: Beach nourishment is the artificial replacement and/or addition of sediment to beaches. The effectiveness of beach nourishment depends on the type of imported sand, natural slope of the beach, cross shore currents, and the frequency of storms. Consideration of natural erosional process is vital to the long-term cost-effectiveness of any beach nourishment program.

b. Dredging: Dredging involves modification of a channel by extracting sediment. Due to the need to dispose of extracted sediment and likelihood of future sedimentation, dredging is usually only undertaken to maintain the navigability of channels and waterways.

3. Shoreline Protection Works

a. Seawalls: Seawalls are vertical walls built on the shoreline that are designed to protect against direct storm wave attack. Seawalls must be constructed of durable, immovable materials to withstand the extreme, dynamic power of storm waves. Due to the size needed to be effective, seawalls can also be curve or stepped to dissipate smaller waves and reflect larger storm waves.

b. Revetments: Revetments are designed to protect the backshore from high tides and surges. Revetments may be constructed out of a number of materials and configurations, from boulders placed at the edge of a cliff or along the backshore, to securing loose material in wire gabions, to pre-cast armor units. Revetments are more successful on lower energy coasts.

c. Bulkheads: Bulkheads are vertical walls on the shoreline, often constructed of wood or steel, and designed to retain loose fill and sediment behind it. Since the purpose of bulkheads is to maintain the material behind it rather than provide protection from the sea or lake, bulkheads are usually not good protection from storms or other flooding events.

d. Breakwaters: Unlike seawalls, revetments, and bulkheads, breakwaters protect the shoreline by breaking down incoming waves to diffuse and refract the wave fronts. Breakwaters must be strong to be effective because they receive the full force of the wave energy. Consideration of materials is especially important for breakwaters due to the environmental forces acting on them.

e. Construction and stabilization of sand dunes: Construction of new sand dunes requires an understanding of the biological and physical processes of the coastal zone. Most effective methods of creating new dunes involves disrupting the airflow to encourage sand deposition, through the use of fences made of porous materials. It is important that the fences alter the air flow but do not halt it. Artificial dunes can also be built up by the planting of vegetation. It is important to note the distinction between vegetation used for dune construction and for dune stabilization, as they are usually of different species. Stabilization, as opposed to construction, of dunes is aimed at securing bare sand surfaces against deflation. Stabilization can be achieved through grading, rapid construction of new dunes through the use of earth-moving equipment, surface fixing by addition of chemicals, and planting of vegetation, focusing on grasses, shrubs, and trees.

4. Flood Control Works

a. Dams and reservoirs: A dam is a structure built across a waterway to impound water. Dams, as well as acting as flood control devices, also serve for maintaining water depths for navigation, irrigation, water supply, hydropower and others. Dams can serve as effective flood control measures by retaining water and releasing it at a controlled rate that does not overwhelm the capacity of the channel beyond. Any dam or reservoir should include a spillway—a feature of a dam allowing excess water to pass without overtopping the dam. Usually a spillway functions only in a large flood. Storage capacity of a dam or reservoir should be a primary consideration in design and construction. In addition, the normal sediment load on the waterway to be dammed plays an important role in the long-term viability of the dam. Sedimentation can silt-up a reservoir and increase its volume, decreasing its flood storage capacity.

b. Dikes and levees: Dikes and levees are often used synonymously. Dikes are usually an earthen or rock structure built partially across a river for the purpose of maintaining the depth and location of a navigation channel. Levees are earthen embankments used to protect low-lying lands from flooding. Levees are built between the floodway and the structures to which they are intended to protect. The effectiveness of a levee to reduce the threat of flood damage on structures and low-lying areas depends on the levee being located outside of the floodway and compensating for the flood storage displaced by it. Locating a levee (or any other structure) within the floodplain can increase the flood height, increasing flood threat both up and downstream.

c. Retaining ponds: Retaining ponds or retention ponds are basins designed to catch surface runoff to prevent its flow directly into a stream or river. Retention ponds are frequently a relatively inexpensive option, provided that ample undeveloped land is available. Retaining ponds have the added advantage

of not altering the character of the stream. Retaining ponds can also act as groundwater recharging sites and reduce water pollution through soil filtering.

d. Flood channels: Channelization is a general term for various modifications of the stream channel that are usually intended to increase the velocity of the water flow, the volume of the water channel, or both. These modifications, in turn, increase the discharge of the stream, and the rate at which surplus water is carried away. The channel can be widened or deepened, especially where soil erosion and subsequent deposition in the stream have partially filled in the channel. Care must be taken, however, that channelization does not alter the stream dynamics too greatly elsewhere. Flood channels or storm sewers are installed to keep water from flooding streets during heavy rains, and, often, the storm water is channeled straight into a nearby stream. This can become a problem by increasing the probability of flooding downstream through greater water volume in streams than would occur naturally. This is particularly a problem when the flood channel is cement lined, thereby further increasing the rate at which water enters streams.

e. Floodwall: A floodwall is a reinforced concrete wall that acts as a barrier against floodwaters. Floodwalls are usually built in lieu of levees where the space between land and the floodplain is limited.

5. Stormwater Management: Beyond maintenance and improvement of urban storm water systems, land treatment measures are effective means of counter-acting the effects of urbanization (particularly the increase in impervious surfaces) on runoff. Land treatment measures include maintenance of trees, shrubbery, and vegetative cover; terracing; slope stabilization; grass waterways; contour plowing; and strip farming. The use of perennial vegetation, such as grasses, shrubs and trees provide cover for the soil, prevent erosion, slow the rate of runoff and increase infiltration, and reduce water pollution. Terracing involves a raised bank of earth having vertical or sloping sides and a flat top for controlling surface runoff. Strip cropping is the growing of crops in a systematic arrangement of strips or bands along a contour.

6. Drainage system maintenance: Maintenance of channels and detention basins is necessarily an ongoing venture due to blockages caused by overgrowth, debris, sedimentation, and aging of systems. Replacement and/or improvement of culverts, mains, stormwater lines, sewer pipes, backup valves, etc., may be part of a general program of maintenance and improvement to reduce flooding hazards.

7. Slope stabilization: A number of potential methods are available to stabilize slopes from landslides, including slope reduction, adding retention structures, fluid removal, and others. Slope reduction involves reducing the slope angle, placing additional support material at the foot of the slope to prevent a slide or flow at the base of the slope, and/or reducing the load on the slope by removing some of the materials high on the slope. Retention structures may include ground cover and retaining walls. The most successful retaining walls tend to be low, thick walls placed at the toe of a slide. Fluid removal acts to reduce the role water can play in landslide by covering the surface with impermeable material and diverting runoff away from the slope, as well as installing a subsurface drainage system. Other methods include cementing the slide material, bolting a rock slide, and the driving of vertical piles into the foot of the slope.

8. Brush clearing, controlled burns, fuels breaks: Brush clearing, controlled burns, and creating fuels breaks are all ways of mitigating the threat from wildfires by reducing the material that can be burned and the area in which it can spread.

9. Wetland preservation: Wetlands are areas that are normally inundated with water. Many important ecological communities are found in wetlands, including bottomland hardwoods, swamps, marshes, bogs, sloughs, potholes, wet meadows, river overflow, mud flats, and natural ponds, and are essential for a number of species of fish and wildlife. Wetlands act as flood control by storing tremendous amounts of floodwaters, slowing and reducing downstream flows. Wetlands also play an important role in coastal productivity and the cycling of river-borne material (pollutants included) by acting as a biogeochemical filter.

B. Strengthening Buildings and Facilities

1. Strengthening Buildings

a. Floodproofing: Floodproofing can be done in two ways: dry and wet. Dry floodproofing involves the sealing of a building against floodwaters by making all areas below the flood protection level watertight. This can be done by coating walls with waterproofing compounds or plastic sheeting and protecting building openings with removable shields or sandbags. Dry floodproofing is limited to 2 or 3 feet above the foundation of the building due to the pressure exerted by deeper water on the walls and floors. With wet floodproofing, floodwaters are intentionally allowed to enter a building to reduce the pressure exerted by deep water. Wet floodproofing at minimum involves the removal of some valuable items and extends to the rebuilding of floodable areas. Wet floodproofing can dramatically reduce damage costs by simply removing furniture and electrical appliances out of the floodprone area.

b. Elevating: Elevating a building is the raising of that building above the flood level. This is the one of the best techniques for protecting buildings that are, or for some reason must be, located in areas prone to flooding. Elevation is cheaper than relocation and is less disruptive to the neighborhood. Effective elevation should take in consideration the need to wet floodproof everything still located in the floodprone area, such as basements or garages.

c. Windproofing: Windproofing focuses on design and construction of a building to withstand wind damage. This involves the aerodynamics of a structure, materials used, and addition of features such as storm shutters.

d. Basement protection: Basement protection may involve floodproofing of the structure, both wet and dry, as well as building a barrier around the opening to the basement to protect it from floodwaters.

e. Seismic retrofitting: Seismic retrofitting involves adding braces, removing overhangs, and providing flexible utility connections and tie downs to reduce damage.

2. Strengthening Facilities

a. Floodproofing: Floodproofing can be done in two ways: dry and wet. Dry floodproofing involves the sealing of a facility against floodwaters by making all areas below the flood protection level

watertight. This can be done by coating walls with waterproofing compounds or plastic sheeting and protecting facility openings with removable shields or sandbags. Dry floodproofing is limited to 2 or 3 feet above the foundation of the facility due to the pressure exerted by deeper water on the walls and floors. With wet floodproofing, floodwaters are intentionally allowed to enter a facility to reduce the pressure exerted by deep water. Wet floodproofing at minimum involves the removal of some valuable items and extends to the rebuilding of floodable areas.

b. Burial: Burial can play an important role in protecting necessarily utility connections, particularly during high winds and ice storms.

c. Elevating: Elevation of facilities is the raising of the facility above the flood level. Of particular importance for facilities is the elevation of electrical and mechanical equipment. It may not be possible to effectively raise many facilities, but by elevating electrical and mechanical equipment, the facility should be able to recover quicker after a disaster.

d. Seismic retrofitting: Seismic retrofitting involves adding braces, removing overhangs, and providing flexible utility connections and tie downs to reduce damage.

e. Improvements to stormwater/wastewater/water treatment facilities, pump stations: Improvements to stormwater, wastewater, water treatment facilities, and pump stations should be undertaken to minimize threat from flooding and other disasters. Capacity of these systems should be evaluated and, if necessary, increased to meet realistic demands.

f. Upgrading piers/wharves: Wharves and piers should be upgraded and retrofitted to match the storm forces they are exposed to.

g. Repair/reconstruction of fuel storage tanks: Fuel storage tanks need to be inspected and if necessary, repaired or reconstructed in the event of flooding or earthquake.

h. Storm shutters: Storm shutters are an important defense against high winds. Storm shutters protect a facility by preventing winds from entering a building and possibly damaging it.

3. Building Codes: Building codes are laws, ordinances, or governmental regulations setting forth standards and requirements for the construction, maintenance, operation, occupancy, use or appearance of buildings, premises, and dwelling units. Building codes should be designed to ensure that development is built to withstand natural hazards. Regulatory standards should be created for the following:

- a. Freeboard
- b. Foundation Design
- c. Wind Standards
- d. Cumulative Substantial Improvement
- e. Lower Substantial Improvement
- f. Critical Facilities
- g. Enclosure Limits
- h. Electrical and Mechanical Equipment

II. Nonstructural Elements

A. Development Management

1. Planning

a. General comprehensive planning: Comprehensive plans and land use plans identify how a community should be developed and where development should not occur. Uses of the land can be tailored to match the land's hazards, typically by reserving hazard areas for parks, golf courses, backyards, wildlife refuges, natural areas, or similar compatible uses. Generally, a plan has limited authority. It reflects what the community would like to see happen. Its utility is that it guides other local measures, such as capital improvement programs, zoning ordinances, and subdivision ordinances.

b. Storm hazard mitigation and post-storm reconstruction plans: A locality should develop a set of policies or planning instruments to have in place to facilitate post-storm decision making. This allows for substantial amount of decision-making to occur prior to the disaster event and permits better decision-making after the event. Storm hazard mitigation and post-storm reconstruction plans should identify priorities both for reconstruction and mitigation.

2. Development Regulations

a. Zoning: Zoning is the division of a jurisdiction into districts and the prescription of uses for which buildings within designated districts may be put—their lot size, yard size, etc.

i) Overlay zones: These zones coexist with other zones, operating like a transparency overlaying existing land use controls. Examples include floodplain and historic districts; within these areas development is regulated by the standard zoning ordinance and the unique requirements of the overlay zone.

Overlay zones allow communities to isolate and protect areas not covered by the rest of the ordinance. However, like any zoning, the protections of overlay zones can be changed or removed.

ii) Agricultural zones: This zoning category sets a minimum lot acreage calibrated to the size necessary to maintain a commercial farm (which varies depending on the predominant crops grown in the region). Some ordinances contain a prohibition on non-farm uses (exclusive use).

An unintended consequence of the diminution of property value is that farmers are deprived of the collateral necessary for financing, making farming unfeasible. Non-exclusive use leads to renting, which does not induce major improvements in the land. A lack of such improvements reduces the viability of farming in the larger area, which in turn creates pressure to allow development. Finally, as with any zoning, this category must allow some reasonable economic use.

iii) Contract or conditional zoning: Under both approaches the landowner agrees to previously unstated conditions (which can be in the form of deed restrictions) in exchange for some government action (such as a rezoning) or an exemption from other conditions. The difference between the two is that with contract zoning the government is contractually obligated to allow the use.

The purpose of these techniques is to provide flexibility in dealing with a small number of land parcels, but they can nevertheless be unpopular with developers. Contract zoning is vulnerable

to an *ultra vires* challenge (the government has impermissibly delegated its authority), and both can be challenged under uniformity provision (that all land in zoning district be subject to the same restrictions), as spot zoning, or as contradicting a comprehensive plan.

iv) Special exception: This term, which is often used interchangeably with conditional use, is used for activities which are permissible but require an additional layer of approval because they need additional attention or cannot be reasonably accommodated in a traditional zoning ordinance. In some cases the use can be by right if the developer meets certain conditions.

While designating most uses as special exception may be illegal, the application of the technique against all new development has been upheld when used in connection with interim zoning or if the jurisdiction already had an adequate facilities requirement.

v) Bonus and incentive zoning: In exchange for concessions from a developer, some governments allow developers to exceed limitations imposed by current regulations, such as building height or dwelling unit density.

This technique has not seen much use outside of non-metropolitan areas. While similar to the accepted practice of dedication, bonuses and incentives may be vulnerable as contract zoning, and the extent of the connection needed between the concession and the government purpose is not clear.

vi) Floating zones: These zones appear in the text of zoning ordinance, but not on the map, and are typically used for shopping centers, industrial areas, mobile home parks, or multi-family housing.

While the location of floating zones can be subject to special interests and politics, they are usually based on facts, as opposed to speculated future needs. They may be vulnerable to a challenge of giving too much discretionary power or as spot zoning.

vii) Density transfers/ average density/ cluster: This type of regulation allows flexible design of large or small scale developments that are constructed as a unit; the actual design is matter of negotiation, but the basic premise is that some areas are developed more intensively than would normally be allowed, while others are used less than what the market would determine. The type of development usually has to conform to zoning, but there is a trend toward allowing mixed use.

The government's goal for this designation is to create open space, protect sensitive features and/or allow farming to continue, while the developer benefits for the higher dwelling unit density or floor area ratios. One consequence can be a form of leapfrog development, with its more expensive public services. Some farm-related uses may be incompatible with residential development, and development can lower farming activity below a critical mass.

viii) Performance or impact zoning: Rather than enumerating permitted uses, performance zoning sets standards for the effects or level of impact allowed for development. The standards may govern traffic, runoff, or viewsheds. The ordinance could theoretically allow any use as long as it met the requirements, but in practice most performance controls are used in conjunction with traditional zoning.

The level of expertise and size of the staff required to implement the standards depends on their comprehensiveness and how much of the jurisdiction they encompass. Performance zoning gives developers greater flexibility, but in some cases it may make enforcement more difficult. In addition, some impacts are difficult or impossible to quantify.

ix) Urban growth boundary: Urban containment basically involves designating a perimeter around an urban area. Urban development is encouraged within the line and discouraged beyond it, generally by restricting land to resource use and very low density residential development and precluding the extension of urban services. The area within the perimeter is designed to be sufficient to accommodate the area's growth for a specified period.

The objective of urban containment is to promote compact and contiguous development, to preserve resource production lands, open space, and sensitive areas, and create a clear boundary between urban and rural areas. If the area is too large, the boundary may not achieve its goal of compact development; if it's too small, property values may increase dramatically.

x) Specific development plans; shadow platting: This technique creates a plan which describes land uses and subdivisions in greater detail and covers a smaller area than a comprehensive plan, zoning map, or public facilities plan. The plan may include designation of specific uses and/or design standards that vary from the zoning ordinance and may even contain enough detail to allow approval of developments which comply without public hearing.

The objective of these plans is to preclude inefficient land use in areas designated for future growth at urban densities. The plans can also create neighborhood identity, coordinate development of different properties, and establish a fast track for development approvals.

xi) Total population limits; development caps: As the name implies, these are absolute limits on housing units or population itself. If a limit succeeds in limiting growth but demand for housing is high, property values will necessarily increase, which can affect the character of the community. The limits themselves do not address quality, type and location of growth, and restricting only one development sector can lead to an imbalance of growth. Not surprisingly, a restriction on growth can cause development to leapfrog out to neighboring jurisdictions.

xii) Rate allocation systems; growth phasing: Allocation systems and growth phases specify a rate of growth, which can be a percentage of total growth or a set number of units or square footage allowed per year.

These techniques are versatile, as they can be used to address quality, type and location of growth. In some cases developers compete for points which allow them to build. The points are based on criteria deemed desirable by the community, such as open space preservation, but the competition itself can be complex and time consuming to administer. If the rate or phases are slower than the market, property values will necessarily increase, which can affect the character of the community. A slower than market rate can also cause growth leapfrog out to neighboring jurisdictions. Applying the phases to less than all development sectors can lead to an imbalance of growth. The rates or phases can be used to ensure the adequacy of lumpy investments, such as water treatment plants, which serve the entire community and cannot be provided incrementally.

xiii) Mandatory low-income housing construction ordinance: These ordinances require those developing large residential projects (often over 50 units, sale or rental) to include a certain percentage of subsidized or low-cost housing (typically 10 to 15 percent of the total number of dwelling units). This requirement can be made economically feasible by tying it to the availability of federal subsidies or tax credits, or increasing allowable densities.

In addition to increasing the stock of lower income housing, these ordinances seek to avoid concentration and improve housing quality. In order to be effective the area needs to have growth pressures, a relatively high rate of return development, and there should be little opportunity to serve

the same market by simply building in a jurisdiction without a low income ordinance. These ordinances may face substantial due process challenges.

xiv) Local environmental impact ordinances: Reports to local governments on environmental impacts generally mention alternatives, mitigation strategies, and irreversible changes.

By forcing developers to account for their environmental values, local governments gain the authority to encourage environmentally sound land use practices. To be effective, the local government must have the technical capacity to review the impact statements.

3. Land and Property Acquisition

a. Fee-simple acquisition of undeveloped land: Fee-simple acquisition of undeveloped land includes the purchase of the full “bundle of rights” contained in real property. Fee-simple acquisition of undeveloped land is important for two reasons. First, it can involve removal of hazardous sites from the private market, thereby reducing potential threat to the public. Second, fee-simple acquisition can act as a development management tool for guiding the location of development. Fee-simple acquisition can be prohibitively expensive, leading localities to alternative ways to finance and manage property, such as land banking and use of restrictive covenants.

b. Relocation of existing development: Relocation of existing development is the surest and safest way to protect it from hazardous threats. However, relocation can become more problematic if the buildings are large and heavy, making a move difficult. Relocation can also be very expensive, especially when there is a large amount of development in the hazard prone area.

c. Purchase of development rights/easements: The owner of an easement has one or more of the several rights in land, leaving the rest in the hands of the land owner. Easements either grant an affirmative right to use property, such as a right of access, or restrict the land owner’s right to use the property in a particular way. Local governments can purchase an easement in development rights and thus preclude building on the property.

By owning the development rights, the government has a very high level of control while allowing the land to remain in private hands. However, the government does lose money twice: in the purchase and foregone tax revenue from the reduced property value. The government must also police the easement, since unenforced rights may eventually be forfeited.

d. Transfer of development rights: These programs treat development as commodity separate from land itself. The government awards development rights based on value or acreage of land, and establishes sending and receiving areas for these rights. The sending areas contain land the government, for various reasons, seeks to protect. In these zones landowners do not have enough rights to develop their land, but they can sell rights to developers in receiving areas. With these rights projects can take on higher densities than would otherwise be permissible. In addition to density, TDR programs can be used to affect the type of uses if the rights are for specific kinds of development, as opposed to one general purpose right.

Besides protecting sensitive areas, TDR programs are supposed to reduce the land value shifts of zoning by compensating those who can’t fully develop their land. However, it is a complex system, which makes it difficult for planning staffs to implement and landowners to understand and accept. TDR programs alone cannot ensure quality development or that there will be a critical mass of resource operations (for example, that there will be enough farms to support the area’s feed

stores). Perhaps most importantly, the region must have enough development pressure to make the rights marketable.

e. Advance site acquisition (land banking): This technique involves the purchase of land by the government for eventual use or resale to the private sector in order to influence the character and/or timing of growth.

While on the surface land banking may seem simple, there are several potential problems, limitations and reasons for opposition: the public sector, rather than private landowners, receive the benefits of property value increase; value of land outside the land bank may be reduced because it eliminates the possibility of developer-contrived scarcities, and the government may sell land at below market prices; it requires high level of expertise on the part of planning staff; bridging the gap between revenues from sale of land and purchase of the land may require debt financing, which will create pressure to increase sale prices; the problems addressed by land banking are often regional, and thus beyond the power of most jurisdictions.

f. Purchase sellback/leaseback: The government can control the use of its land by selling or leasing it to the private sector with restrictions, covenants and/or negative easements.

In so doing the government maintains control without having to actually manage the property. Though less involved than management, the leasing or selling authority does need to ensure compliance with the terms of the agreement. Where the government sells the property, the restrictions lower the tax burden on the owner.

g. Purchase option (right of first refusal): A right of first refusal guarantees the government the first opportunity to purchase the property, while an option prevents the sale of the property to another party for specified period.

If the budget does not have room for an outright purchase, this can be an effective protection, but it can also be an unnecessary expense if the government will buy the property anyway. In addition, the property may become more expensive in between buying the option or first refusal right and the actual purchase. On the other hand, designation of future acquisition may reduce the property value, possibly making the government liable for damages if it does not go through with the purchase.

h. “Sword of Damocles” provision: A government agency with the power of eminent domain suspends condemnation of land covered by a comprehensive plan as long as the land use remains compatible with the plan. If the landowner proposes or commences a use in contravention of the plan, the land is taken into public ownership.

The federal government has used this approach in Idaho’s Sawtooth National Recreation Area. These provisions allow land to remain in private ownership and are an effective, inexpensive protection tool in the short run. However, increasing land values may encourage property owners to develop incompatible uses and make the cost of condemnation prohibitive. If on the other hand, land values are suppressed by the provisions, governments may face political pressure to remove them.

4. Taxation, Fiscal, and Other Incentives

a. Differential assessment/taxation: This technique can take on several different forms: reducing the tax rate applied to the assessed value of resource production land such that payments only cover essential services; reducing the assessed value of resource production land such that payments only cover essential services; reducing the assessed value of land to a percentage of urban land; assess the value based on current income-producing capacity, as opposed to the market value (most states allow land in several specified uses, such as forests and open space, but some limit to farmland).

The differential assessment reduces the tax burden on land facing development pressure and recognizes that some tracts put less demand on services funded by property taxes. The flip side of this recognition is that the loss of tax revenue can be substantial. An unintended consequence of having preferential status is that it can be a haven for speculation as property value rises, and can force development further out as close-in property owners hold out and sustain tax benefits. This effect can be reduced with either a use change/conveyance penalty, or a deferred taxation system, where the difference between market and preferential taxes are paid when the property is converted to a higher use (laws vary, but the range is five to ten years of tax deferred taxes due). However, the amount of accumulated taxes may not be enough to offset profits, and there may be a leapfrog effect because land farther out will have lower market value and thus lower accumulated taxes. In addition, basing the tax rate on income production for a specific property will encourage development of best farmland because it will have the lowest accumulation of deferred taxes (which can be avoided by having a uniform rate). The few legal challenges have been based on uniform taxation provisions in state constitutions.

b. Land gains taxation, transfer or development taxes: Vermont is the only state to employ a tax on the profits gained from the sale of land. The amount is inversely proportional to the length of time land is held, and it can apply only to value of land, not improvements. There is an exception for the principal residence of seller. Transfer taxes are simply assessed against the seller of land devoted to certain designated uses. Development taxes are charged against developers obtaining permits to convert land in certain categories to more intense uses.

These taxes discourage conversion to higher density, slow the growth rate, and discourage speculation, but they also are not effective for long term protection and may limit needed economic development while owners hold out on selling their property. The land gains tax may be vulnerable to legal challenge under the uniformity clause in state constitutions or based on discrimination against non-residents because of the principal residence exception. On the other hand, the Vermont law sustained a Fourteenth amendment challenge of arbitrary discrimination against land owners of less than six years.

c. Special assessments districts: Special assessment districts include property owners who benefit from a specific public improvement. These owners are charged a fee, which can be based on an attribute(s) of the property that is proportional to the benefits received from the improvement, and is charged to both new and existing development. There are numerous possibilities, from temporary creations designed simply to raise revenue for a specific improvement to independent, special purpose governmental entities. A commonly used example is the transportation utility fee. While exactions, bonds, impact fees and other methods are used to pay for transportation improvements, the utility fee covers the maintenance/operation cost of the system(s).

Since this is not a tax, special assessment districts are free from constitutional requirements of uniformity, equality and double taxation. This technique shifts the financial burden from the general public to those directly benefiting. The revenues are more predictable than sources which depend on development cycles, which makes issuing bonds easier.

d. Impact fees/system development charges: These assessments are typically one time, up front charges (some jurisdictions allow extended payments) against new development to pay for off-site improvements. The fees can also be set up to have growth buy into existing services with excess capacity. Two specific examples of impact fees are: 1) Family Reservation Fees—where developers pay up front for their proportionate share of future improvements or expansions, and 2) Linkage Fees—where non-residential development finances needs linked to the new development, such as affordable housing.

Impact fees can fund wider variety of services than exactions or special districts, and can cover the full costs of improvement, unlike land dedication requirements. On the other hand, impact fees do not help with maintenance costs. They are typically used in place of negotiated exactions, which take longer and are less predictable or equitable. Finally, every impact fee must meet a three part legal test: 1) need for improvements is created by new development, 2) the amount charged the new development is proportionate, 3) all revenues must be spent in proximity to the new development and within a reasonable period of time.

e. Development impact tax/improvement tax: These are taxes on new construction, including alterations to existing structures, usually paid while applying for building permit.

Unlike a fee, this charge does not need to be based on the cost of improvements needed to serve the new development, and there are no restrictions on how the revenues can be spent.

f. Developer Exactions: These are private sector investments in public infrastructure needs created by new development. Exactions can take the form of on or off site improvements or land dedication, and are often a condition for approval.

There needs to be a rough proportionality between the exaction and the development's impact. For this reason land dedications are good, as they have a close relationship to the development, but dedications don't cover the cost of improvements. Negotiated exactions do allow financing of improvements and can be very specific, but they also create problems: improvements usually reflect the needs of individual developments and not the community as a whole; they are not predictable; particular geographical conditions or bargaining ability may make some exactions appear inequitable; small developments may not be subject to the same kind or degree of exactions as large ones, even though they can have the same or greater cumulative effect; exactions do not cover maintenance costs.

5. Capital Facilities Policy: This technique creates a timetable and budget of when, where, and what level of municipal services a government will supply.

The timetable controls growth because it is rarely feasible for a developer to provide services, and capital programming is less expensive and less likely to face legal challenges than many other growth management techniques.

a. Focused public investment plan (FPIP): Basically a Capital Improvements Plan for a specific area, known as a Public Investment Area (PIA). A Focused Public Investment Plan (FPIP) coordinates and concentrates investments such as water, sewer, streets, schools and parks. While

funding mechanisms and expected contributions from developers may vary, the objective is to supply fully served land for development.

FPIPs limit growth which is dispersed and has inadequate public services. PIAs allow governments to choose which parts of the jurisdiction are suited for growth, which can include areas free of environmentally sensitive features and infill/redevelopment sites. Carefully chosen PIAs will also minimize the overall cost of providing services. FPIPs make it easier to create a system of development charges which is equitable and understandable to the developer.

b. Service areas: The taxing authority of a government can designate areas which will receive services and those that will not, and tax the former at a higher rate.

This technique will be more effective if used in conjunction with a regulatory program which limits development in areas with lower, more attractive tax rates, and a capital program will make the designation more equitable and less open to legal challenge. (The uniformity of taxation provision in most state constitutions can be the basis for legal challenge.)

c. Marginal cost pricing: Under this system new development is responsible for the incremental cost of the service needs it creates (for example, paying per foot for water and sewer) as opposed to average cost pricing (charging the same regardless of real costs). The latter form of pricing creates an incentive for low density growth away from existing services, since it is effectively subsidized higher density, close-in development.

The complexity of marginal cost pricing leads to the creation of price districts instead of pricing each development, which can lead to a problem at the district borders; people will understandably ask why they have to pay more than their next-door neighbor.

d. Concurrency/Adequate public facilities requirement: This is a required level of municipal services that must exist when the proposed development is completed or within a certain period afterward.

The requirement can have the effect of encouraging development in areas already well served by public facilities, and/or shifting development to jurisdictions with lower service requirements. Demanding service requirements also may discourage certain types of development, especially high density.

6. Land Use Policy: The above development management tools should be incorporated into well defined policies (such as expressed through a comprehensive or land use plan) that address the location, density and use of land, paying special attention to high risk areas. Development should be located away from high hazard areas. Density should reflect the impacts of development on the environment, as well as the ability of local government to protect the community, and need to evacuate the area. Use of land should be also be reflective of the impacts on the environment and reduction of hazards.

7. Moratoria: A moratorium is a short-term suspension of right to develop, usually done by not issuing permits. Moratoria can play an important role following a disaster, to set priorities for response and potential mitigation efforts.

8. Reconstruction Triage: Reconstruction triage is the sorting of priorities for reconstruction. The use of a triage for decisions on reconstruction should be outlined in a post-disaster reconstruction plan, created prior to the disaster.

B. Subdivision Regulations: The division of a lot, tract of parcel into two or more lots, tracts, parcels, or other divisions of land for sale or development.

C. Information Dissemination

1. Real Estate Disclosure Requirements: Real estate disclosure requirements would require notification that the property to be purchased is located in a hazard prone area and is notified of this. Currently, federally regulated lending institutions must advise applicants for a mortgage or other loan that it is to be secured on a building which is in a floodplain as shown on the Flood Insurance Rate Map. Since this requirement has to be met only five days before closing, often the applicant is already committed to purchasing the property when he or she first learns of the flood hazard. State laws and local practices by local real estate boards can overcome this deficiency and advising newcomers about the hazard earlier. They may also require disclosure of past disaster events, regardless of whether the property is in a mapped high risk zone. Terms and maps of used for disclosure of hazard risk should be meaningful to homebuyers.

2. Community Awareness Programs: Community awareness programs may be used in conjunction with and/or in place of real estate disclosure requirements to directly educate the potential homebuyer and the community of hazard risks. Information can be presented in a number of ways, including information pamphlets, brochures, literature and workshops. Topic may include identification of hazards, things to consider in purchasing a home or business, ways to limit exposure and reduce future property damages.

3. Hazard Disclosure

a. Mapping Hazards: The application of vulnerability and/or risk analysis, inventories, and other studies to maps is an important step in reducing disaster potential. Locating hazards can be accomplished through cooperation with a number of federal and state agencies. Use of a geographic information system to overlay high risk areas over property maps can serve as indicators of sites for mitigation.

b. Notification: Notification of the locations of hazards and the risks needs to be given to public officials, public employees and agencies, the general public, and the private sector. Notification can be given through workshops, information pamphlets, brochures, literature, etc. It is important that information on the location of hazards is shared between agencies to ensure better decision-making.

4. Disaster Warning: The first step in responding to a potential disaster is to know that one is coming. This may require monitoring of local conditions. Disaster warnings can be administered in a number of ways, including via sirens, radio, television, cable TV, mobile public address systems, telephone trees, and even door-to-door contact. Multiple or redundant warning systems are most effective, as the message will be received even if one part of the warning system is not heard.

5. Workshops: Workshops can play a valuable role in preparation for a disaster. Workshops can be arranged for public employees and/or state agencies, for general public, and for public officials. These workshops should include education regarding the potential hazards, possible mitigation steps that can be taken, and how to respond after a disaster occurs.

6. Education and training: Education and training for awareness of hazards, mitigation steps, and disaster response should not only be targeted to public employees, agencies, and public officials, but should also include the general public and the private sector.

III. Private Sector

A. Lending: The application of a real estate disclosure requirement or other information to lending sources regarding the risk of development in hazard prone areas would reduce to cost of lending both to the lending institutions and consumers of their services. It is important that lending institutions understand the risk of supporting development in high risk areas.

B. Insurance: The insurance industry plays an important part in the private sector guiding of development. The National Flood Insurance Program is a good example of how the insurance industry can also play a role in promoting development that reduces hazard risk.

C. Building Industry: The building industry should be educated to the structural and building codes designed to reduce damage from hazardous events. The building industry should also be educated on the location of high risk areas and ways to mitigate hazardous threats.