Hawaii Coastal Hazard Mitigation Guidebook

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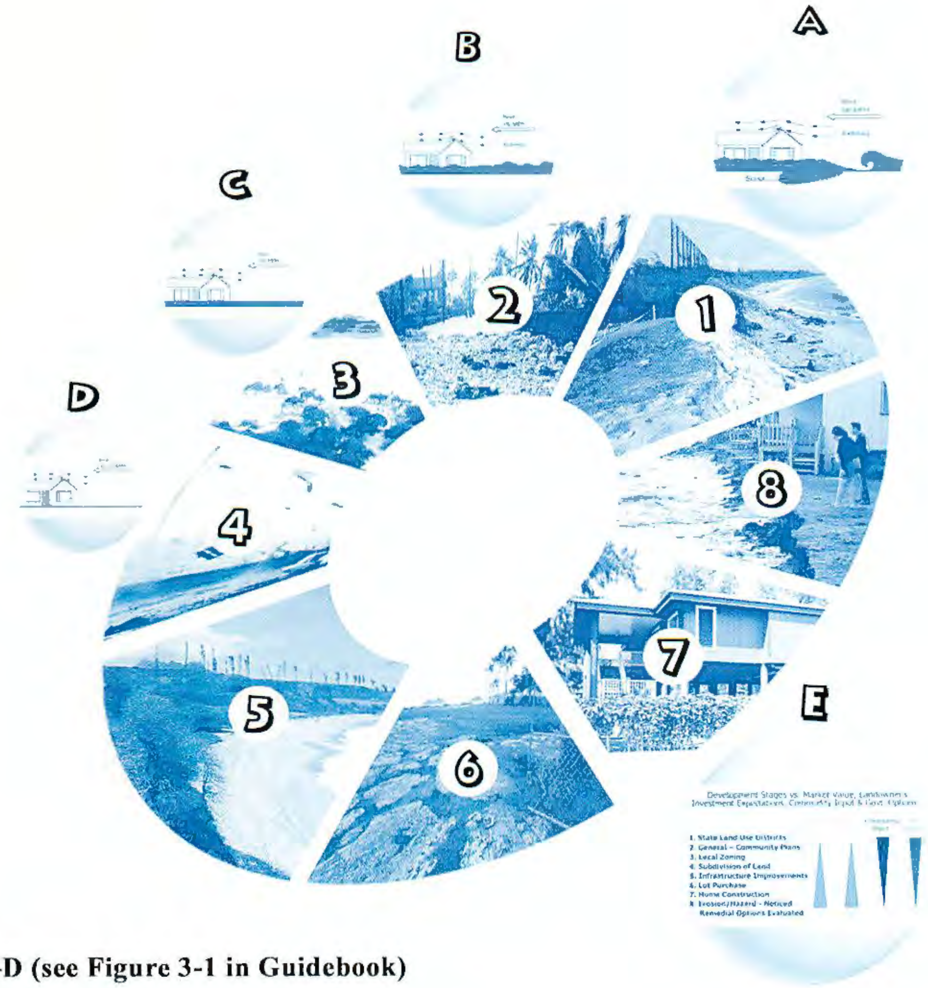
NOAA Pacific Services Center
KO KĀKOU KAPAKAI, KO KĀKOU MUA



Spheres A–B–C–D (see Figure 3-1 in Guidebook)

Illustrate the key hazard zones discussed in the Guidebook.
(A) Closest to the shoreline is the erosion zone, where structures are exposed to erosion, scour, wave action, flooding and wind forces. (B) Farther inland is the wave zone (FEMA's V-VE zones) subject to wave action, flooding and wind. (C) Structures in the flood zone (FEMA's A-AE-X zones) are at risk from flood and wind damage. (D) Farthest inland, structures are subject primarily to wind forces. Concept from FEMA Coastal Construction Manual and Texas Coastal and Marine Council. Corresponding Photos 1 through 4.

1. Erosion at Wailua Golf Course on Kauai.
2. Wave action from Hurricane Iniki washes coral debris onto Makua Street in Makaha, Oahu. Photo from Carl Viti of The Honolulu Advertiser.
3. Flooding at Ala Moana Beach Park on Oahu during Hurricane Iniki. Photo from T. Umeda of The Honolulu Advertiser.
4. Wind debris, such as sheets of roofing, and a pallet fly through the air during Hurricane Iniki at Lihue, Kauai. Photo from Bruce Asato of The Honolulu Advertiser.

Sphere E (see Figure 2-5 in Guidebook)

The Guidebook divides the development process into stages and hazard mitigation options are discussed that are appropriate for each stage. Corresponding Photos 5 through 8.

5. Undeveloped land at Kealia Kumuukumu aka Donkey Beach, Kauai. See Figure 2-3.
6. Empty lot ready for construction at Lanikai Beach, Oahu. See Figure 11-1.
7. House built on stilts to withstand wave and flood forces at Haena, Kauai. See Figure 2-7.
8. Homeowners observe erosion of the shoreline at Aliomanu Bay, Kauai. See Figure 1-11.
   Photo from Dennis Fujimoto of the Garden Island News.

Hawaii Coastal Hazard Mitigation Guidebook

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Foreword

Aloha. We are pleased to present the Hawaii Coastal Hazard Mitigation Guidebook. Although the beautiful coastline of Hawaii is greatly appreciated, the risks involved with natural hazards often are not. The State makes an ongoing effort to work with many organizations to develop methods that reduce exposure to natural hazards such as erosion, flooding, wave action, earthquakes, subsidence, lava, tsunamis, and hurricanes. Guidebooks such as this are an important step in developing strategies for coastal hazard mitigation.

The measures presented in this Guidebook are for educational and discussion purposes, and neither the State, nor the counties, have currently adopted the manual as official policy. It will be up to individual agencies to decide, after further discussion of the strategies, or any subsequently developed, how much or little should be adopted.

We hope you find the Guidebook informative and will consider implementation of the mitigation measures and strategies as future decisions along our coast are made.

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Preface

This manual provides guidance in the planning and siting of coastal projects to reduce risks from natural hazards. Building near the ocean is inherently dangerous and despite these guidelines, risk can never be completely eliminated for any development along the coast.

Following this manual does not relieve a project applicant from the duty to comply with all federal, state and local laws. The information provided in this manual is intended as general guidance regarding coastal hazards such as erosion and flooding. It is the duty of an applicant for development to design a project that is tailored to meet the specific coastal and oceanographic conditions of the site and to obtain proper approvals based on the overall merits of the project. The guidance provided in this manual is neither an endorsement for nor against a certain project, but is designed simply to reduce the exposure of coastal developments to natural hazards.

This manual can be used as a reference guide for safe coastal development. However, the measures in this manual are not meant to exclude other sound methods of hazard mitigation. Although specific suggestions and measures are provided, there may be other methods to avoid risks from coastal hazards. It is up to the design professional, planner, engineer, architect or agency to utilize the measures in this manual as applicable, or research and design measures that may be more effective, given the particular site conditions.

This manual provides information about companies performing ocean engineering and shoreline protection work. It does not provide a complete listing of all companies performing work in this area, and is not intended to serve as an endorsement of the companies listed herein. Determination of a company's qualifications is the sole responsibility of the reader.

The guidance provided herein may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity by any person against the sponsors, reviewers, agencies, organizations or individuals associated with this manual.

Overview

The purpose of this guidebook is to reduce risk to coastal development by planning for natural hazards such as erosion, flooding, tsunamis, and hurricanes. The guidebook builds on many of the concepts covered in the Federal Emergency Management Agency's Coastal Construction Manual ("FEMA CCM") but covers, to a greater degree, the issue of proper siting of development. Without proper siting, even the best construction methods cannot prevent damage from natural hazards.

Following the guidance in this manual will help to reduce the exposure to coastal hazards. With the goal of encouraging more responsible development, this manual does not seek to prohibit new projects, but to insure that if they do proceed, the resulting structures are appropriately sited and constructed. By doing so, coastal communities can be protected and the State's coastal resources preserved.

Since the guidebook covers hazard mitigation measures for the various stages of development, the intended audience is broad and includes regulators, community groups, neighborhood boards, planners, architects, coastal engineers, landowners, existing homeowners and even potential purchasers of coastal property.

The major concepts in this book are explained in the figures and tables provided within each chapter. These visual aids will allow the reader to quickly review the material and obtain a cursory understanding of the subject matter in each chapter and how it relates to other sections of the book. More detailed information on subject matter covered by the graphical aids is provided in the text for that chapter, or by cited references within. To further assist the reader, a brief summary of the chapters in the guidebook follows below.

Chapter 1 - Introduction

Chapter 1 outlines the reasons to plan for coastal hazards. If coastal hazards are not considered in the development process, homeowners may be subject to unnecessary and increased risks from wave inundation, flooding and erosion. Furthermore, severe environmental damage may result in the form of beach loss. Hawaii is particularly susceptible to erosion, flooding, hurricanes and tsunamis. Since the area exposed to risk from each hazard overlaps, planning for one hazard reduces the risk of property damage from other hazards.

Chapter 2 – Implementation Strategy

In order to better plan and implement hazard mitigation measures, the development process has been broken up into eight generalized stages: (1) State district classification, (2) county general and community planning, (3) county zoning, (4) subdivision of land, (5) infrastructure improvements, (6) lot purchase (where disclosure issues are of importance), (7) home construction (or infill lot stage), and (8) erosion or hazard noticed, remedial actions analyzed. To facilitate implementation, it is necessary to break the development process into stages, because at each stage, there are different rules, agencies and parties, as well as hazard issues and mitigation measures involved. Each stage of development is covered in a chapter (Chapters 5 through 12).

It is recommended that hazard mitigation be addressed as early as possible in the development process because with each stage that a project passes through, the rights of the landowner become greater, the community has fewer opportunities to provide input, and the land becomes more valuable. As a result, the government's ability to mitigate damage from hazards diminishes significantly.

This manual develops technically based setbacks for various hazard zones. Once the technical standards are set, implementation strategies are provided for different stages of development that consider government duty, the need to mitigate for coastal hazards, impact on the landowner, protection of the homeowner, community desires, protection of the environment, the land use process, and fairness in general. In general, the later in the development process hazard mitigation measures are addressed, the more likely that the standards implemented will not be technically based or as protective.

This manual provides guidance and implements measures through a light handed government approach that emphasizes knowledge, information, guidance, policy, industry standards and the use of existing regulatory authority. The identification of existing and applicable laws and regulations is provided in each chapter so that the need for new regulations can be minimized.

Chapter 3 – Relationship of Erosion with Other Coastal Hazards

In Chapter 3, the erosion, wave, flood and inland zones are defined. The erosion zone is closest to the coast and subject to the most intense and varied forces (wind, flooding, high velocity wave action, scour and erosion). The erosion zone can be determined using the standards in this manual and is based on an erosion trend, a storm event, and a design safety buffer. The wave zone corresponds to FEMA's V and VE zones on the Flood Insurance Rate Maps ("FIRMs") and corresponds to areas subject to wind, flooding and high velocity wave action. The flood zone corresponds to FEMA's A, AE, and X zones and is subject to wind, flooding and possibly lower velocity wave action. The inland zone is farthest inland, subject to wind action, and defined as areas inland of FEMA's A, AE or X zones.

Designating hazard zones in this scheme has three advantages. First, they are readily identifiable and, except for the erosion zone, already determined. Second, they incorporate tsunami and hurricane inundation data since the FIRMs for Hawaii are based on these hazards. Finally, this hazard zonation scheme forms a horizontal continuum of zones that will facilitate hazard mitigation, strategy development and land use planning.

Chapter 3 also reviews the hazards that Hawaii is subject to such as erosion, bluff erosion, flooding, lava, tsunamis, earthquakes, hurricanes, and subsidence. A determination is made as to whether each hazard is primarily a siting or construction issue. This will assist the agencies, landowner and public as to what stage of development is most appropriate for the hazard to be addressed.

Chapter 4 – Determining the Erosion, Wave, Flood and Inland Zone in the Hazard Assessment

Due to the need for early planning, a hazard assessment is recommended for any project on the coast that requires a state district land use reclassification, general or community plan amendment, county zoning change or subdivision approval (Stages 1 through 4 in the development hierarchy). At the heart of the hazard assessment would be an erosion analysis. Existing erosion data can be used in the erosion analysis, but if the data is outdated, or the analysis is too remote from the site, it is recommended that the landowner hire a qualified consultant to follow the standards provided in this manual.

Once a hazard or erosion assessment is conducted, the work need not be duplicated for subsequent stages of development. For the later stages of development (Stage 7 – home construction on infill lots), if no existing hazard or erosion analysis is available, it is recommended that an erosion study be performed instead of a full hazard assessment.

Currently, Hawaii's environmental assessment process is not sufficient to address hazard mitigation for two reasons. First, an environmental assessment may not be triggered for certain early stages of development that are critical to hazard mitigation such as: (i) changes to general, community and development plans; (ii) small zoning changes; and (iii) land use district reclassifications at the county level. Due to the lack of a consistent early trigger, the landowner may spend significant time and money on project design even before key hazard mitigation issues are identified, thus leaving the problem to be addressed at later stages of development. Second, environmental assessment policy in Hawaii does not follow a uniform standard for hazard mitigation analysis. In Chapter 4, a standard is provided to determine the erosion rate and conduct a hazard assessment.

The standard for evaluating erosion is based on the life expectancy of a structure, the erosion rate, a storm event and a safety buffer. Placing a structure a uniform, set distance from the shoreline is not sufficient. For example, erosion problems can be expected when a house with an anticipated life of 70 years is placed 40 to 60 feet inland from a shoreline eroding one foot per year. The setback of 40 to 60 feet is the unscientific standard for Hawaiian shorelines.

It is recommended that a 70-year time frame be used as the planning period for new subdivisions with small structures. A 100-year period is preferable for subdivisions with large structures, and for district reclassifications or zoning changes in which the use has not been established.

The erosion, wave (V-VE), flood (A-AE-X) and inland zones can be identified in the hazard assessment. The hazard assessment can be separate from or part of an environmental assessment. Since the hazard assessment is so important in siting, it is recommended that it be conducted as early as possible in a development stage and incorporated with any environmental assessment that is later required.

Chapter 5 – State Land Use Districts (Stage 1)

For State district reclassifications, any changes to increase the density of use should require a hazard assessment. With such an assessment, the erosion, wave (V-VE), flood (A-AE-X) and inland zone as well as the parcel up for consideration can be superimposed on one map. Depending on the size of the lot compared to the hazard zone, the alternatives may include: (i) no change to increase density, (ii) change to a higher density use but not the highest or (iii) change to the highest density with a technically-based safety buffer as a condition for approval that runs with the land. Conditions that run with the land can be used to propagate hazard mitigation measures down the development chain.

A key in the decision making process is the percent that development restrictions consume the lot. In most cases, the area of control on development will be very small compared to the overall property size. Addressing the hazard mitigation issue early increases the likelihood that economic and environmental impacts can be minimized.

Development should be avoided in erosion zones. Many hazard mitigation manuals also recommend avoiding development in the wave and perhaps the flood zone. This is an issue for the agencies to decide and the answer is partly determined if the hazard can be mitigated properly during the construction stage by elevating the structure. This manual recommends that consideration of restrictions on siting in the wave and flood zones be analyzed when the hazard assessment is conducted.

Whether compensation tools are provided or not to implement a proper safety setback, the agencies should always strive to minimize impact to the landowner while insuring that there are technically-based standards for coastal hazard mitigation. Utilizing this philosophy is the most efficient, fair and feasible approach to the implementation of mitigation measures addressing coastal hazards. These concepts apply to all decisions in the development chain.

Chapter 6 – General, Community and Facility Planning (Stage 2)

General, community or facility plans provide an opportunity for the community, businesses and the landowner to map a vision for coastal development. Furthermore, these plans create future expectations that can be relied on by all parties involved in the development process. General and community plans should contain detailed objectives, policies and implementation measures regarding hazard mitigation. Sample objective, policies and implementation measures are provided in this chapter.

Chapter 7 – County Zoning (Stage 3)

Zoning at the county level is important in hazard mitigation since the purpose of zoning is to designate a suitable use for the particular land in question. A factor in suitability of residential use is if the area is subject to undue erosion, wave inundation or flooding risks. Care should be taken in making zoning decisions that increase the density of residential use for coastal areas subject to erosion, wave inundation or flooding. In this guidebook, the decision-making process to implement hazard mitigation measures at the county zoning stage is analogous to that for the State district classification stage (Chapter 5).

Chapter 8 – Subdivision of Land (Stage 4)

A key stage in hazard mitigation is the subdivision process. A seemingly forgotten provision in the subdivision regulations of all the counties provides that created lots are to be suitable for their intended use and free from flooding or erosion risks to future occupants. To comply with these provisions, it is recommended that a hazard assessment be conducted before work on the preliminary plat for the subdivision begins. The hazard assessment should be done early, for if the issue is not planned for by the landowner, a predictable but undetected problem is likely to pass down the development chain and resurface as a more burdensome and threatening issue for the buyer (future homeowner). By employing innovative and flexible design before the preliminary plat is created, it is possible, in most cases, to implement a scientifically based safety buffer while significantly minimizing impact to the landowner and homeowner.

That lots need to be suitable for their intended use during the subdivision process (Stage 4) should guide decisions up the development chain--otherwise there could be a conflict. For example, changes to a State district classification (Stage 1), community plan (Stage 2) or county zone (Stage 3) may call for residential use in an unidentified erosion zone. If an erosion zone were later identified in the subdivision process (Stage 4), then under the subdivision regulations, residential use should not proceed in that area although this could conflict with prior development decisions. This is an additional reason that hazard mitigation should be addressed in the earliest stages of development (Stages 1 through 3).

Chapter 9 – Infrastructure Improvements (Stage 5)

The Chapter on infrastructure improvements concentrates on preserving coastal dunes to prevent flooding, wave inundation and slow erosion. Also important is the placement, layout and configuration of major and arterial roadways serving coastal properties. It is important for State and county agencies to assess coastal hazards early in the development process in order to reduce future costs associated with infrastructure repairs. In addition, poorly planned roadway location may result in the creation of coastal lots that cannot accommodate a sufficient safety buffer.

Chapter 10 – Lot Purchase (Stage 6)

For lot transfers, the major issue has to do with the disclosure of hazard risks. Improvements are recommended to State disclosure laws so that: (i) there is proper disclosure of risks such as erosion, and (ii) greater incentive is provided to the landowner to properly design subdivisions that mitigate the risks of coastal hazards.

Chapter 11 – Home Construction (Stage 7)

The risks from many hazards can be addressed during the home construction stage. For example, hurricane wind and rain, earthquake forces, and certain types of flooding can be addressed by creating a wind and rain resistant construction envelope, following applicable building codes and elevating structures above the Base Flood Elevation.

Although it is late in the development process to address the siting of a new house on an existing lot, it is suggested that scientifically based shoreline setbacks be implemented to provide greater safety to future residents. Various minimum buildable area formulas are discussed in the chapter that can minimize the economic impact of such setbacks in the case where existing lots are small.

Chapter 12 – Erosion/Hazard Noticed – Remedial Options Evaluated (Stage 8)

Sometimes coastal hazards are discovered after the home is constructed and parties move in. Numerous references are provided on how to deal with these situations. The alternatives to deal with erosion such as shoreline hardening, sand replenishment and dune restoration are reviewed. Sources for retrofitting a house to deal with hurricane wind and rain are provided.

Chapter 13 – Conclusion

A goal of this book is to identify technically based standards for hazard mitigation. Once identified, regulatory flexibility and creativity can be used to implement strategies that take into account legal, political, economic, environmental and fairness factors to arrive at a realistic and balanced decision. In Chapter 13, many of the flexible strategies developed throughout this book are discussed for the implementation of a technically based siting standard for coastal erosion. Similar strategies can also be applied for the implementation of any other siting standard related to the mitigation of hazards for flooding, wave inundation, hurricanes, tsunamis, lava, subsidence and earthquakes.

In addition to the thirteen chapters in the guidebook, this manual is supplemented with the following five appendices:

Appendix A

In this appendix is found an updated summary of existing coastal management reports that was originally contained in the State Coastal Erosion Management Plan ("COEMAP"). These reports provide additional guidance in the mitigation of coastal erosion and other hazard risks.

Appendix B

Appendix B provides a partial listing of coastal engineering companies and organizations that can assist in the planning and assessment of erosion and hazard risks.

Appendix C

This appendix contains a list of companies or organizations in which historical aerial photographic data can be obtained. Such data would be required for a historical erosion analysis.

Appendix D

In this appendix, the law of regulatory takings is summarized with the layperson in mind. The relationship between the police power of an agency to regulate land for the public good and the property rights of landowners is discussed.

Appendix E

A glossary is provided to assist the reader in understanding key terms and acronyms. Many of the terms are derived from the Federal Emergency Management Agency's Coastal Construction Manual. For some terms, additional explanation is provided to place the term within Hawaii's coastal and regulatory environment.

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Table of Contents

List of Figures

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Chapter 10

Chapter 11

Chapter 12

Appendix D

List of Tables

Chapter 1 - Introduction

The purpose of this manual is to provide guidance and suggest strategies at all stages of development that will help to reduce (but may not eliminate) the risks from coastal hazards such as erosion, wave inundation and flooding. In doing so, the potential risks from other coastal hazards, such as hurricanes and tsunamis will also be mitigated. While erosion is a problem associated primarily with the beach areas of the State, inundation and flooding are applicable to all coastal areas.

This manual was initiated in response to recommendations in the State Coastal Erosion Management Plan ("COEMAP") establishing the need for a technical guidance manual to reduce erosion risks along the coastline. COEMAP was adopted by the State Board of Land and Natural Resources as well as the State of Hawaii Marine and Coastal Zone Management Advisory Group ("MACZMAG") as a vehicle to provide balance between development and coastal conservation.[1] COEMAP has been endorsed by federal, state and county stakeholders interested in erosion management. While developing the strategy for erosion mitigation, it became apparent that similar concepts could apply to the mitigation of other coastal hazards, further integrating broad based hazard mitigation in the Hawaiian Islands. Thus, this guidebook develops the interrelationship between erosion mitigation and mitigation for other coastal hazards.

This report supports and supplements the Federal Emergency Management Agency's Coastal Construction Manual ("FEMA CCM"). The FEMA CCM emphasizes: (i) building in the right location ("siting") and (ii) utilizing the proper methods of construction. While the FEMA CCM provides considerable guidance on construction techniques, less is provided on how to incorporate siting issues into the development process.

This manual emphasizes coastal siting issues within Hawaii's current statutory and regulatory framework. Reference will be made often to FEMA's CCM, including the citation to specific sections and the inclusion of relevant figures and diagrams. While this manual is applicable to Hawaii's regulatory system, many of the same concepts will be applicable to hazard mitigation planning for other coastal states.

The target audience for this manual is broad. Government agencies can use the manual to formulate policies and standards that guide development in a manner that mitigates the risk of coastal hazards, protects human settlements and preserves natural resources. Landowners, developers, architects and planners may use this manual as an impetus to design projects that result in stronger and safer structures. The public may use the guidebook to identify issues likely to arise in the coastal development process and

[1] Act 169 of the 2001 Session Laws of Hawaii amended Haw. Rev. Stat. § 205A and clarified that MACZMAG was to consist of an all citizens advisory body to advise the Office of Planning and the CZM program.

when their input will be of most use in shaping their community. Consultants may find the manual useful in addressing issues for safely siting structures along the coast in order to avoid impacts from erosion or flooding.

Although much of this manual applies to new coastal developments, it can also be used to address areas recovering from coastal storms and hurricanes. A strategy to rebuild after a natural disaster can be formulated to facilitate implementation of hazard mitigation measures. The strategy would be based on streamlining the permit system with general permits and performance standards for structures that are built further inland, elevated higher or built stronger.

1.1 Beach Dynamics and Coastal Processes

Development of many areas along Hawaii's beaches has assumed a degree of terrain stability that is uncharacteristic of these features. Beaches are dynamic and change on a daily, seasonal and long-term basis in response to sea level changes, ocean currents, waves and wind that move sand along the coast or perpendicular to the coast.

Seasonal high waves will cause a beach to change its shape or "profile" (Figure 1-1). To partially absorb the additional wave energy, beaches and dunes give up sand to the waves which carry it seaward and drop it on the bottom. This raises the seafloor and flattens the overall profile of the beach. Waves then shoal and break further offshore, minimizing their erosive effects. Beaches recover when smaller waves move the sand back onto the beach and winds blow it into the dunes to be captured by coastal vegetation. These changes happen in response to seasonal shifts in wave energy.

On a longer time scale, deficiencies in the sediment budget of a beach or persistent rise in sea level will lead to chronic erosion. This is a condition where the shoreline shifts landward to establish an equilibrium position with respect to the sediment deficiency or the higher position of sea level. Because many coastal lands in Hawaii are underlain by sand, coastal erosion of these lands may release this sand to partially or wholly heal the sand deficit and establish an equilibrium shoreline position under higher water levels. Many sediment deficiencies on beaches are the result of human impacts to sand availability such as beach mining, seawall construction, channel clearing, or other activity.

Problems with coastal development often occur when there is a failure to recognize the interaction between the active beach which is managed by the State and the inland dune and backshore areas, which are generally managed by the counties. It is a misconception to believe that the counties can allow development to occur anywhere mauka of the shoreline (inland of the vegetation line) and the problem with erosion could be taken care of later.

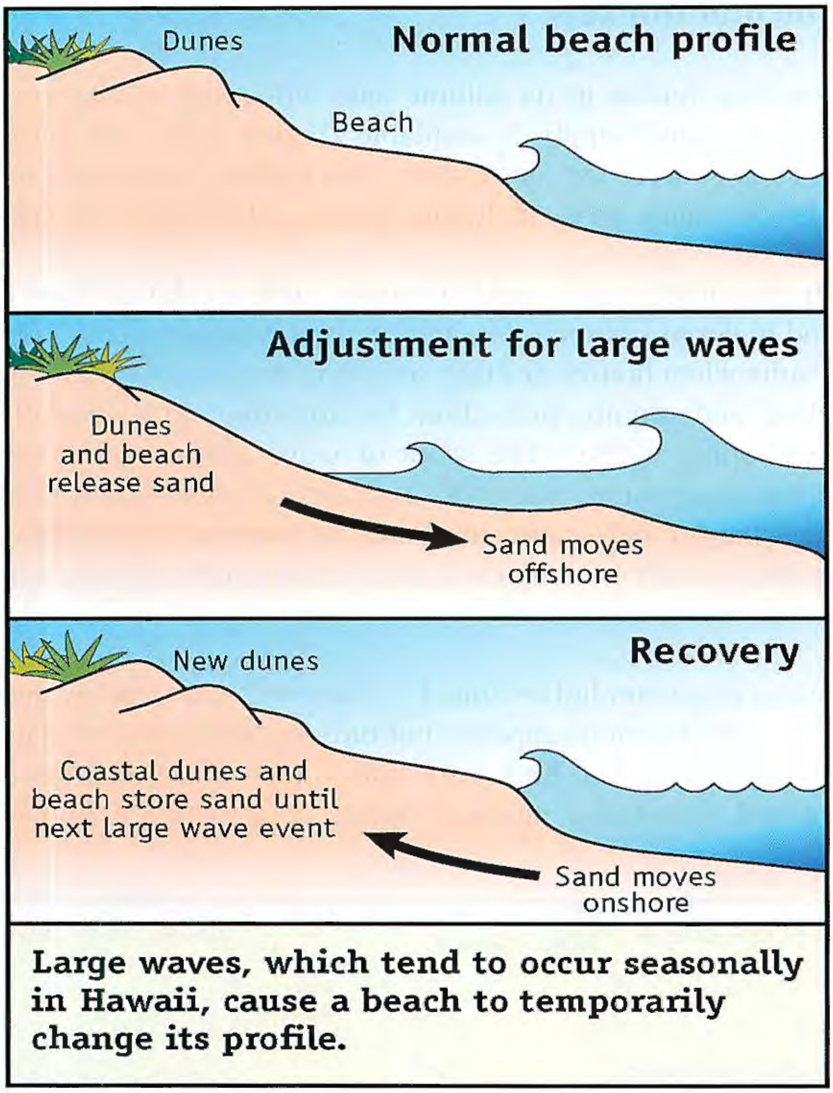


Figure 1-1 – The Dynamic Beach Profile - Wave action grinds up the skeletons of marine organisms to create the white sand on Hawaiian beaches. The dunes are made from sand that is washed or blown inland. During periods of high wave action, sand from erosion of the dunes and from the beach is transported offshore. This raises the seafloor and flattens the beach profile. Waves then shoal and break farther offshore, minimizing their erosive effects. Beaches recover when smaller waves move the sand back onto the beach and winds blow it into the dunes to be captured by coastal vegetation. From Fletcher, SOEST, UH.

1.2 Planning for Coastal Erosion

Past experiences in Hawaii and in the continental United States indicate that remedial engineering along the coast to address coastal hazards is not a substitute for proper planning. It is through early planning that the options to deal with coastal hazards are the least economically burdensome, the most politically acceptable and the most cost effective. Yet in the development of Hawaii's coast, these issues have historically been addressed too late in the development process and have resulted in unnecessary and costly burdens on the government, the landowner, homeowners and the public.

The failure to adequately plan for coastal erosion and flooding have led to numerous problems in Hawaii. These problems are summarized in the remaining sections of this Chapter.

1.2.1 Environmental Impacts

A beach undergoing long-term retreat in its natural state will often maintain its natural width, provided an adequate sand supply is available (Figure 1-2). On most Hawaiian beaches, the primary sand sources are alongshore sand transfer from adjacent beach segments, erosion of backshore sandy areas, including dunes, and offshore sources.

When a retreating beach encounters a non-sand substrate, such as clay soil, or a rocky outcrop, it will narrow and undergo seasonal loss and perhaps permanent loss. On developed shores, beach loss results when houses or other structures are built too close to an eroding or unstable shoreline and require protection by armoring with seawalls (vertical walls) and revetments (sloping walls). The scour of wave action against the hardened barrier, coupled with passive erosion, where the exchange of dune sand to the beach is cut off by the hardened barrier may cause the beach to narrow. Eventually, unless a new sand source is introduced such as along the coast, permanent beach loss will ensue. This problem is called sand impoundment.

Sand on a beach provides an important buffer zone by absorbing wave energy and protecting the abutting land. When the beach disappears, not only is there a loss of state recreational resources and public access, but high surf will often impact hardened barriers, leading to an intense and sometimes unstable buffer zone between human inhabitants and the ocean.

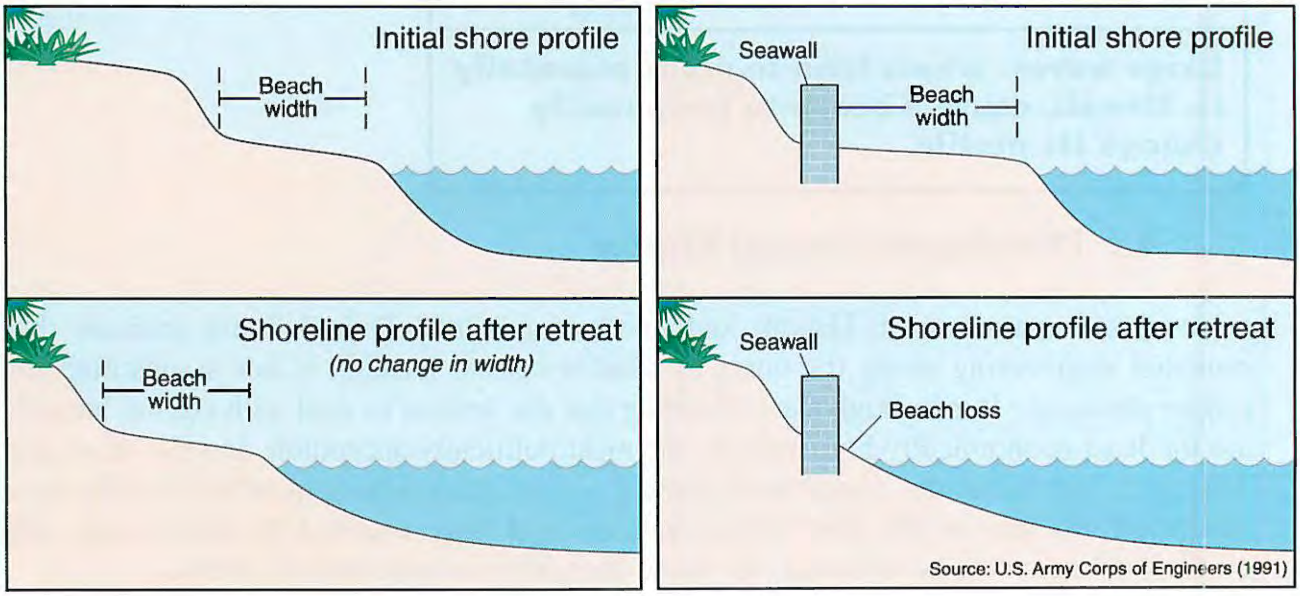


Figure 1-2 – Potential Impact of Seawall - A natural shoreline can generally maintain its width even if the shore is chronically eroding (left). Once the shoreline is hardened (right), wave reflection off the wall, coupled with the cut off of the inland supply sand is likely to lead to the loss of the beach for areas that are chronically eroding. From U.S. Army Corps of Engineers, 1991 – adapted from Fletcher et al., 2002.

An example of beach loss is depicted in a sequence of photographs for Lanikai Beach on Oahu. Figure 1-3 shows that many lots in Lanikai are sufficiently deep to accommodate alternating histories of erosion and accretion, however, houses have been built closer to the shoreline than the road. The recommended location is to build closer to the road. In Figure 1-4, the same structures as viewed from the ocean, are threatened by erosion. Sand bags have been placed to protect the structure, but these function in much the same way as other armoring. A view of the adjacent Lanikai Beach shows that homeowners eventually attempt to permanently fix the position of the shoreline with seawalls and revetments, which results in loss of the public beach (Figure 1-5).

Figure 1-3 - Lanikai Beach, Oahu - View from Road - Deep lots along the shore are large enough to accommodate cycles of erosion and accretion. However, houses are built close to the shoreline, instead of the preferred alternative of building near the road.

Figure 1-4 - Lanikai Beach, Oahu – View from Ocean - Same area as in Figure 1-3. The development close to the shoreline gives the beach no room to accommodate alternating histories of erosion and accretion. Erosion threatens the structures and results in temporary sand bags for protection.

Figure 1-5 - Lanikai Beach, Oahu – Hardened Shoreline - Section adjacent to Figure 1-4 but facing southeast. Homeowners attempt to permanently fix the shoreline with seawalls and revetments. The beach is lost and there is reduced recreational value. Access along the shore is cut off. State resources are impacted.

Studies have reported that nearly 25 percent of sandy beaches on the island of Oahu (17 miles) have been severely narrowed or lost over the past 70 years due to shoreline armoring (COEMAP). Since 1949 or 1950, approximately 4 miles of beaches have been totally lost on the island of Maui (Figure - 1-6).

When a beach is lost, public access along the coast is removed, significant recreational opportunities for residents and tourists of the State are eliminated and the scenic beauty of the islands degraded. Beach loss also results in increased near shore turbidity related to wave reflection against vertical structures. Sand scouring is increased by wave and current funneling against a wall, causing littoral and near shore substrate changes that impact littoral ecosystems.

Figure 1-6 - Kalama Beach Park, Maui - Beach Park on Maui without a beach. A long stretch of shoreline is hardened with a stone revetment along a former beach area.

Based on meetings of the Coastal Erosion Committee with the Office of Planning, there appears to be a continued trend of shoreline hardening as additional applications for seawalls and revetments are being processed throughout the islands. Furthermore, the highways of the State are subject to erosion in numerous areas and hardening is being considered as a solution in many localities.

The figures above demonstrate that erosion problems and beach loss are directly related to where structures are placed along the shoreline. These are siting issues that will be discussed later in this manual. While the counties have control of how land is developed mauka of the shoreline, it is the State that suffers the consequences of improper siting of coastal structures since the loss of a beach results in impacts to State environmental, recreational and scenic resources.

Many public access ways required by the State to be along the shore no longer lead to recreational areas that were guaranteed for public use.[2] Instead, they lead to intense zones in which high energy waves break against a wall, prohibiting recreational use and access along the shore (Figure 1-7). The original purpose of providing access towards the shore is thus defeated.

[2] Haw. Rev. Stat. § 46-6.5

Figure 1-7 – Shoreline Public Access – An increasing number of public access ways required under State & county law no longer lead to recreational areas, but walled fortifications. Waves break against the wall and run up the access way, eliminating access along the shore (horizontal access) and restricting ingress to the shore (vertical access).

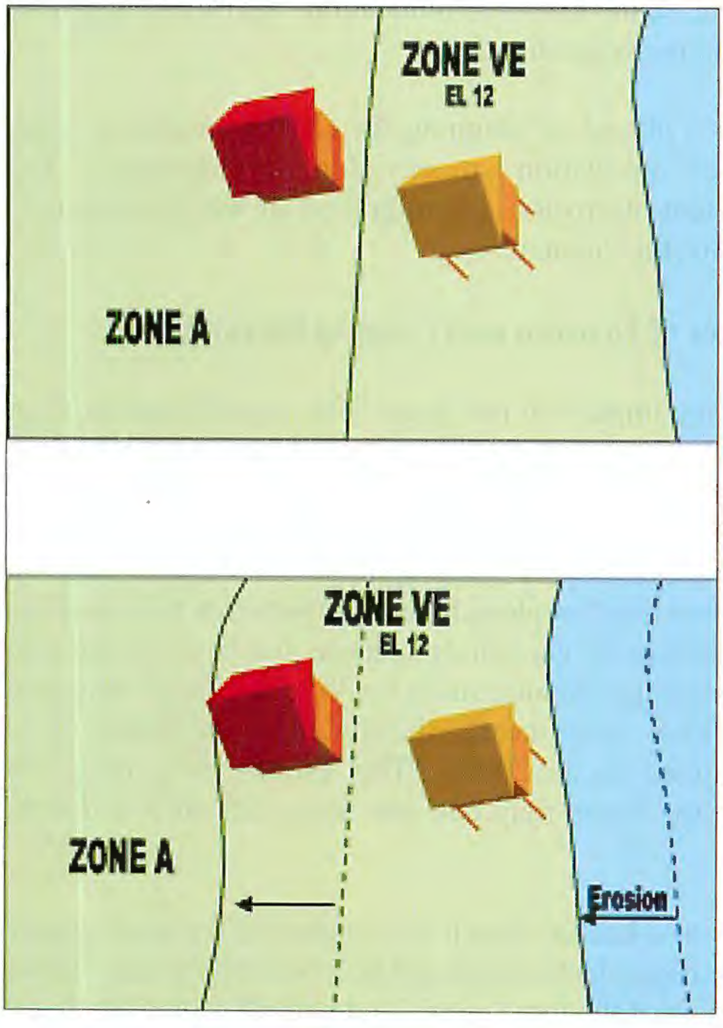
There is a vested interest in the State to be involved in the planning of coastal development since siting decisions that do not consider scientifically based setbacks inevitably impact significant State resources (Figure 1-8). Standards for technically based setbacks are provided in this manual (Chapter 4). By planning early for erosion, wave and flooding problems in the siting of shoreline structures, environmental impacts can be avoided with the least burden to the landowner and the government agencies.

Figure 1-8 – Kekaha Kai Beach, County of Hawaii - The State has an interest in preventing natural shorelines such as this and in Figure 2-3 from turning into hardened shorelines such as seen in Figures 1-5 through 1-7. Planning for erosion and other coastal hazards during the early stages of development is vital.

1.2.2 Relationship of Erosion with Other Coastal Hazards

Hawaii is subject to many coastal hazards including erosion, flooding, hurricanes and tsunamis. Over time, coastal erosion increases the risk of flooding (Heinz Study - Evaluation of Erosion Hazards, 2000; FEMA CCM, 2000). This is because as the shoreline recedes, coastal structures move closer to wave action that can inundate a property. Furthermore, erosion removes trees, brush or other coastal vegetation that act as barriers to diminish flood inundation elevation and the inland distance of run up.

Properties that may previously have been in the coastal A-zone may, because of erosion, have migrated into the high intensity coastal V-zone (Figure 1-9). By building structures away from unstable shorelines and generally at a higher elevation, both erosion and flooding risks are reduced.



(a) The two houses shown are both post-Flood Insurance Rate Map (FIRM) structures. The house on the right is located within the V-zone and hence required to be elevated on pilings. The other house, located in an A-zone, is not required to be elevated on pilings, and instead is elevated on solid perimeter walls.

(b)Thirty years later, the beach has eroded and the FIRM for the area has been revised. Erosion has modified the hydrodynamics of the area and the V-zone has shifted landward so that the house on the left now is located in the V-zone. However, its owner still pays A-zone rates (because of grandfathering), and it is not built to V-zone standards. As a result, there is much greater potential for damage or catastrophic failure.

Figure 1-9 – Erosion and Flood Zones - Effect of erosion on the location of flood boundaries and the exposure of structures to wave inundation. Both the V and A zones are subject to the 100 year flood, but the V zone is also subject to high velocity wave action. The E designation indicates a Base Flood Elevation has been determined. From Heinz Study, 2000.

Numerous studies have indicated the hazard mitigation benefit in planning development for erosion. The report "Designing for Tsunamis – Seven Principles for Planning and Designing for Tsunami Hazards" recognizes that tsunami hazards overlap other hazards and that mitigation for hazards such as erosion, flooding and hurricanes can assist in mitigating the damage from tsunamis (National Tsunami Hazard Mitigation Program, 2001). The Draft Report, "A Multi-Hazard Mitigation Strategy for Maui County," notes that coastal setbacks not only reduce the risk of property loss from coastal erosion, but the risks of deaths from tsunamis and storm surge (Pogue, 2000).

The Flood Insurance Study for Kauai County explains that flood inundation limits from the 100-year tsunami are based on existing conditions (FEMA, 1995). Any modification or alteration to existing conditions may have a significant effect on inundation limits. For instance, the reduction of surface roughness, such as caused by the removal of native vegetation could increase the extent of inundation. Erosion is a natural process that can cause the removal of native vegetation.

In this manual, much emphasis is placed on planning for coastal erosion in order to implement an overall multi-hazard mitigation strategy for development. The relationship between the horizontal extent of erosion and migration of the flood zone is discussed in greater detail in Chapter 4 of this manual.

1.2.3 Economic Impact of Erosion and Coastal Hazards

Natural hazards have an economic impact on the State. The impact derives from harm to natural resources, property damage, the cost of remedial options to address coastal hazards and recovery from the hazard itself.

It is difficult to quantify the economic impact in tourism that lost beaches have on the State. Studies have shown that certain beach replenishment projects in which beaches are created have a positive effect on tourism by generating income that pays for the cost of replenishment many times over. A recent economic study for Waikiki Beach indicated that due to the poor and narrow condition of the beach, the State may be losing up to $181 million each year in tourism dollars (Lent, 2002). This estimate was based on existing visitor surveys. To replenish the beach may cost the State $25 million dollars over a five-year period.[3]

These studies on the economics of a healthy beach are conducted for high density beach areas and the outcome is heavily dependant on user traffic. Nevertheless, it cannot be beneficial for State tourism when some of the most scenic and natural shorelines in the State are lost by improperly planned development.

[3] Honolulu Advertiser, July 6, 2003

There is also a great economic impact due to damage from natural hazards. In a 1993 study conducted by the Center for Development Studies, Social Science Research Institute of the University of Hawaii at Manoa, damage from Hurricanes Iwa (1982) and Iniki (1992) on Kauai was compared with damage estimates if a similar size storm struck the other islands. Asset losses on Kauai from Iniki was estimated at $1.56 billion and included damage to residential structures, personal property, visitor accommodations, tourism facilities, non-Federal public property and agriculture. This estimate does not include economic loss from lost visitor expenditures ($763 million) or job loss. Furthermore, the numbers do not reflect human suffering and personal loss. An estimate of the amount of damage if similar size storms struck the other islands is summarized in Table 1-1.

Table 1-1 - Asset Damage from Hurricanes Iwa and Iniki on Kauai and Expected Damage from Similar Storms on other Islands (Center for Development Studies, SSRI, UH, 1993)

Island	Iwa	Iniki
Kauai[1]	$492	$1,564
Oahu[2]	$6,025	$18,568
Maui[2]	$1,135	$3,599
Hawaii[2]	$1,121	$3,521

Numbers in millions of dollars

[1] Based on actual damage estimates after Hurricane Iwa hit Kauai in 1982 and Hurricane Iniki struck Kauai in 1992

[2] Hypothetical damage estimates for a similar size storm

In a scenario where an Iniki-type hurricane strikes the island of Oahu, the resulting damage was estimated at $18.6 billion dollars, excluding lost visitor expenditures and job loss. By comparison, when Hurricane Andrew struck Florida in 1992, it was the most costly storm-related disaster in U.S. history with damages exceeding $15 billion (Insurance Research Council and Insurance Institute for Property Loss Reduction, 1995).

In the 1993 SSRI-UH report, numerous hazard mitigation options were recommended, including increasing the shoreline setbacks to reduce the risk of future wave and storm damage. Due to the damage from overwash and wave action inflicted by Hurricane Iniki, the Hazard Mitigation Task Force convened by the Federal Emergency Management Agency also recommended that coastal setbacks be deepened. By increasing the shoreline setback to address coastal erosion and flooding, an important mitigation benefit is obtained in reducing risk from wave and storm damage from hurricanes and tsunamis.

Small inexpensive planning and design changes early in the development process can result in avoiding significant personal and property damage later on. This benefit relates to safer development for citizens of the State and a decreased vulnerability to economic trauma when a major disaster does occur.

1.2.4 Burden on Coastal Residents

From discussion with State and county agencies as well as coastal homeowners, dealing with erosion is time consuming, expensive and emotionally draining. Residents have testified that it is very stressful to observe erosion that destroys their property and threatens the loss of their home. During storms or high surf, waves crashing against hardened barriers such as seawalls and revetments can threaten the integrity of these structures and generate sufficient noise to disturb sleep. Coastal residents worry frequently that their homes may not endure severe storms or the pounding from high surf (Figure 1-10).[4] Often, homeowners are so threatened by erosion that they become desperate and will place boulders and rocks along the shore without the required permits. This creates an enforcement problem for the State. Other homeowners, upon learning about erosion along the shoreline will attempt to resell the property as quickly as possible.[5]

Figure 1-10 - November 22, 1995 Storm - Sugar Cove, Maui. With no beach in front of the boulder wall, winter waves impinge on the entire length of the wall. Buildings are inundated as waves crash against the hardened structures and reach the 2nd story bedrooms. Photo by Barbara Guild, Sugar Cove, Maui.

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[4] From written testimonies of residents of Sugar Cove, Maui.

[5] Interview with Sam Lemmo, Manager, Office of Conservation & Coastal Lands, DLNR

It is traumatic when coastal homeowners experience erosion, flooding and wave inundation of their property (Figure 1-11). The financial burden is equally great and more easily documented. To deal with erosion after a house is built in the erosion zone, costly studies are required to obtain permits for remedial measures such as sea bags. If these bags are not effective, additional studies may be required before a more expensive structure, such as a revetment is permitted. Preliminary estimates obtained by consultants put the cost of an erosion study and permitting for seabags or a revetment at $25,000 to $50,000. A revetment may cost up to $1,000 per linear foot to install. Therefore, a coastal study, permits and installation of a revetment along a 100 foot lot may cost a single landowner $150,000.

By analyzing historical shoreline changes before development, many of the problems associated with erosion along the coast can be planned for and thus avoided. While historical analysis cannot always predict the future, it does provide a good indication of changes that are likely in an area by documenting how that area has responded to past meteorological and oceanographic events such as El Nino, hurricanes, global warming or storms.

A shoreline study to determine historical erosion rates that can be used for planning may cost from $10,000 to $15,000. A hazard assessment may cost on the order of $25,000 to $35,000 for an entire project. If a developer conducts these studies and plans for erosion during the zoning and subdivision stages, the need for homeowners to conduct more expensive studies and implement erosion remedial measures at a later date can be avoided.

Figure 1-11 – Erosion at Aliomanu Bay, Kauai - Coastal erosion is a significant emotional and financial burden on homeowners. It is much less of a burden for a developer to plan for erosion before development than for homeowners to mitigate the impacts after building has occurred in a hazard zone. Photo by Dennis Fujimoto of Garden Island News.

1.2.5 Government-Homeowner Conflicts

Interviews with government decision makers at the State and county level suggest that dealing with shoreline protection issues is extremely complex and burdensome. Regulators have sympathy for the desperate situation homeowners are confronted with when their property begins to erode. The erosion brings wave action closer to the living quarters of homeowners and increases risk from flood and wave damage. Homeowners are often compelled to harden the shoreline before additional property or structures are lost. Regulators also know that the approval of a structure to harden the shoreline is likely to lead to natural resource damage. As the protector of the natural resources for the public, this creates a dilemma.

Dealing with erosion is time consuming and expensive for both the homeowner and government agencies. For the agencies, time is spent in reviewing reports, obtaining public comments and permitting for proposed coastal measures. Considerable staff time may be spent if there is a dispute with the landowner, who is often in a desperate situation. Coastal homeowners are sometimes so threatened by erosion, flooding or structural damage that they are compelled to protect their property by hardening the shoreline without a permit. This results in the potential for enforcement action and further conflict between the government and the private property owner.

1.2.6 Summary of Erosion and Flooding Impacts

The issues raised in this Chapter provide justification to increase effort to plan for erosion, flooding and other coastal hazards in the development process in order to avoid unnecessary risks. This will require increased cooperation between the State, counties and landowners in order to site a building safely and build stronger along the coast.

Chapter 2 - Implementation Strategy

There are eight guiding principles utilized throughout this manual to facilitate implementation of hazard data and mitigation measures into the siting and design of development. These principles are listed in Figure 2-1 and discussed in detail in this Chapter.

Guiding Principles Integrated into the Hawaii Coastal Hazard Mitigation Guidebook

1) Divide the Development Process into Discrete and Sequential Stages
2) Protect the Homeowner - Consumer through Proper Design and Construction
3) Encourage Community Participation
4) Alleviate the Burdens on the Regulated Community
5) Plan for Multiple-Overlapping Hazards
6) Protect the Environment
7) Implement Technically Based Standards
8) Utilize a Light-Handed Government Approach

Figure 2-1 – Guiding Principles for Implementation - The above principles are incorporated within the Hawaii Coastal Hazard Mitigation Guidebook to facilitate implementation of the hazard mitigation measures and strategies presented.

2.1 The Stages of Coastal Development

Coastal hazards can only truly be avoided by long term planning. Long-term planning should begin at the very earliest stages of development and continue for subsequent development stages. For this manual, the process of coastal development has been divided into eight general stages: (1) State land district classification, (2) county general & community planning; (3) local zoning, (4) subdivision of land, (5) infrastructure improvements, (6) lot purchase, (7) home construction, and (8) erosion/hazard noticed – remedial options evaluated (Figure 2-2).

Figure 2-2 – Stages of Development and Hazard Mitigation Planning - Agencies should consider coastal erosion and other natural hazards in a process that starts at Stage 1 and continues for all subsequent development stages. It is too late in the planning process to address coastal hazards at Stage 8. This will result in severe problems and limited options for the agencies, homeowner and the public.

Every section of the coast is likely to be found in one of the eight stages of development (Figure 2-2). For example, raw undeveloped land may be classified at the State district level, or zoned at the county level, but may not have been subdivided or have infrastructure improvements (Figure 2-3). Conversely, more densely developed coastal areas may have been subdivided and contain necessary infrastructure (Figure 2-4). This guidebook contains a chapter for each stage of development and reviews mitigation measures that are appropriate for that particular stage.

The earlier coastal erosion, flooding and other hazards are addressed in the development process, the more effective and least expensive are the measures to reduce hazard risks. Early planning requires that these issues be addressed during the State district classification as well as the county planning, zoning and subdivision stages (Figure 2-2). Late planning (addressing the issue at Stage 8) will often result in structures that are improperly sited and subject to unnecessary hazard risks.

The eight stages presented are a generalization for Hawaii's current development process. If State district classifications in Hawaii were eventually consolidated at the county level, such as for many U.S. states where all zoning powers are at the local level, the development hierarchy in Figure 2-2 would be similar, except that there would be seven stages instead of eight, with the top stage being the general and community plans. Nevertheless, the concepts in this manual would still be applicable.

Figure 2-3 – Kealia – Kumuukumu aka Donkey Beach, Kauai – Every section of the Hawaiian coast is likely to be in a different stage of development or non-development. The backshore behind Donkey Beach is relatively raw undeveloped land with no infrastructure mauka of the beach.

Figure 2-4 – Puako Bay, Hawaii - This area has been zoned, subdivided and infrastructure has been put in place. The existing empty lot is up for sale.

It is necessary to divide the development process into stages for several reasons. First, different decisions with regard to hazard mitigation siting and construction are made at different stages of development. For example, siting issues for hazard mitigation are most effectively addressed in Stages 1-4 (land district classification, planning, zoning, and subdivision), while disclosure and consumer protection issues arise in Stage 6 (lot transfer) and proper building techniques arise in Stage 7 (home construction). Second, with each stage of development, there are likely to be different parties and design professionals involved. Since mitigation planning involves balancing of differing interests, this balancing must be done with knowledge of the stage of development and therefore, the parties involved. Third, each stage of development is likely to involve a different agency with their own set of administrative rules, practices and policies (Table 2-1). Since this manual attempts to address hazard mitigation within the existing regulatory framework, recognition of the stage of development is vital in formulating effective strategies. Finally, a breakdown of the development process into stages facilitates discussion on the timing and strategy for hazard mitigation implementation, thus allowing for more useful guidance to be provided. For example, with the breakdown into stages, strategies can be provided for when different coastal hazards should be addressed in the development process.

The breakout of development into stages allows a detailed analysis of potential weaknesses in a State's statutory and regulatory program relating to environmental protection and hazard mitigation. Under the Coastal Zone Management Act, HRS 205A-2, there are policies and objectives that relate to reducing the hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence. These issues are commonly not reviewed until the later stages of development, e.g., during a subdivision (Stage 4). By then, many key decisions regarding the value of the land and its intended use may have already been decided. This is likely to make implementation of subsequent hazard mitigation measures significantly more difficult. This manual suggests that key hazard mitigation policies and issues be implemented as early as possible in the land use process, during the State district classification, general and community planning or zoning stages (Stages 1-3).

As the counties develop and implement their hazard mitigation strategy, it is important that they are consistent from one stage of development to the next. A county should not encourage high density use at the zoning and subdivision stage, and then attempt to develop the area in a low density fashion during the home construction stage. This is likely to result in strong objection by landowners and developers, who will claim that they have built up an investment backed expectation. While this may make common sense, it is likely to occur if the issues of erosion and other coastal hazard are not addressed until too late in the development process.

Table 2-1 - Stages in Coastal Development - Key Decisions Regarding Shoreline Management, Different Government Agencies and Parties

Development Stage	Key Coastal Management Decisions	Primary Agencies & Organizations
1. State District Classification	Types of Use, Density of Use	State Land Use Commission and Planning Departments. For Urban, Rural and Ag land less than 15 acres, County Councils and Planning Commissions
2. General & Community Planning	Character of Area, Goals and Policies for Growth and Development, Community Input to Zoning and Subdivisions, Design Standards	Planning & Permitting - Division of Planning & Development; Dept. of Planning; Planning Dept.; Planning Dept.; City Administration, County Councils, Planning Commissions, Citizen Advisory Groups, Government Advisory Committees, Neighborhood Boards, Landowners, Companies
3. Local Zoning	Types of Use, Density of Use	Planning & Permitting - Division of Planning & Development; County Council, Dept. of Planning, Planning Commission, Citizen Advisory Committee; Planning Dept.; Planning Dept., Planning Commission, County Council
4. Subdivision of Land	Location & Size of Lots, Configuration of Lots, Mix of Lot Size, Location of Streets, Cluster Developments, Planned Developments, Planned Unit Developments, Setbacks, Variances	Planning & Permitting - Site Development Division; Dept. of Public Works & Waste Management, Planning Commission, Dept. of Planning; Planning Dept.; Planning Dept., Dept. of Public Works, Dept. of Water Supply
5. Infrastructure Improvement	Preservation of Coastal Dune, Infill of Dune, Grading of Land, Grading Permits, Drainage, Utility Placement	Planning & Permitting - Site Development Division; Dept. of Public Works & Waste Management, Dept. of Water Supply, Dept. of Planning; Public Works - Road Division, Public Works - Engineering; Dept. of Public Works – Engineering Division, Planning Dept.
6. Lot Transfer	Disclosure of Erosion, Flooding & Hazard Risks	State Legislature, Landowner, Homeowner
7. Home Construction	Location of Home on Lot, Setbacks, National Flood Insurance Regulations, Building Codes to Address Wind, Hurricane Damage, Seismic Loads	Dept. of Planning & Permitting - Building Division; Dept. of Public Works & Waste Management, Dept. of Water Supply, Dept. of Planning; Dept. of Public Works - Building Division; Dept. of Public Works - Building Division, Planning Dept.; Dept. of Land and Natural Resources - Office of Conservation & Coastal Lands
8. Erosion /Hazard Noticed – Remedial Options Evaluated	Erosion & Repetitive Flooding, Seawalls, Revetments, Sand replenishment, Dune reconstruction, Retreat, Compensatory mitigation, retrofit	Dept. of Planning & Permitting -Permits Division, Dept. of Planning; Planning Dept.; Planning Dept., Dept of Public Works, Dept. of Land and Natural Resources - Office of Conservation & Coastal Lands

City and County of Honolulu   Maui County   Kauai County   Hawaii County

Black text indicates the organization, agency or entity is not specific to any county

The need to address coastal hazards as early as possible in the land use process is illustrated in Figure 2-5. This figure summarizes, in a generalized manner, the parties involved in coastal development decisions, and their relative rights at different stages of development. From the diagram, as each development stage proceeds, the landowner is likely to invest more time and money into the property to prepare a project for construction. As a corollary, as each stage is passed, the market value of the property would be expected to grow appreciably. This is significant because in resolving coastal conflicts between the public and private sector, one option commonly raised is to buy the property. The government can attempt to buy property at Stages 1 or 2, when it is relatively cheap, or it can wait until Stage 7, when the property could become prohibitively expensive. However, waiting to address the coastal hazards issue until the later stages of development is clearly an improper strategy and will likely foreclose the government's ability to acquire expensive coastal land.

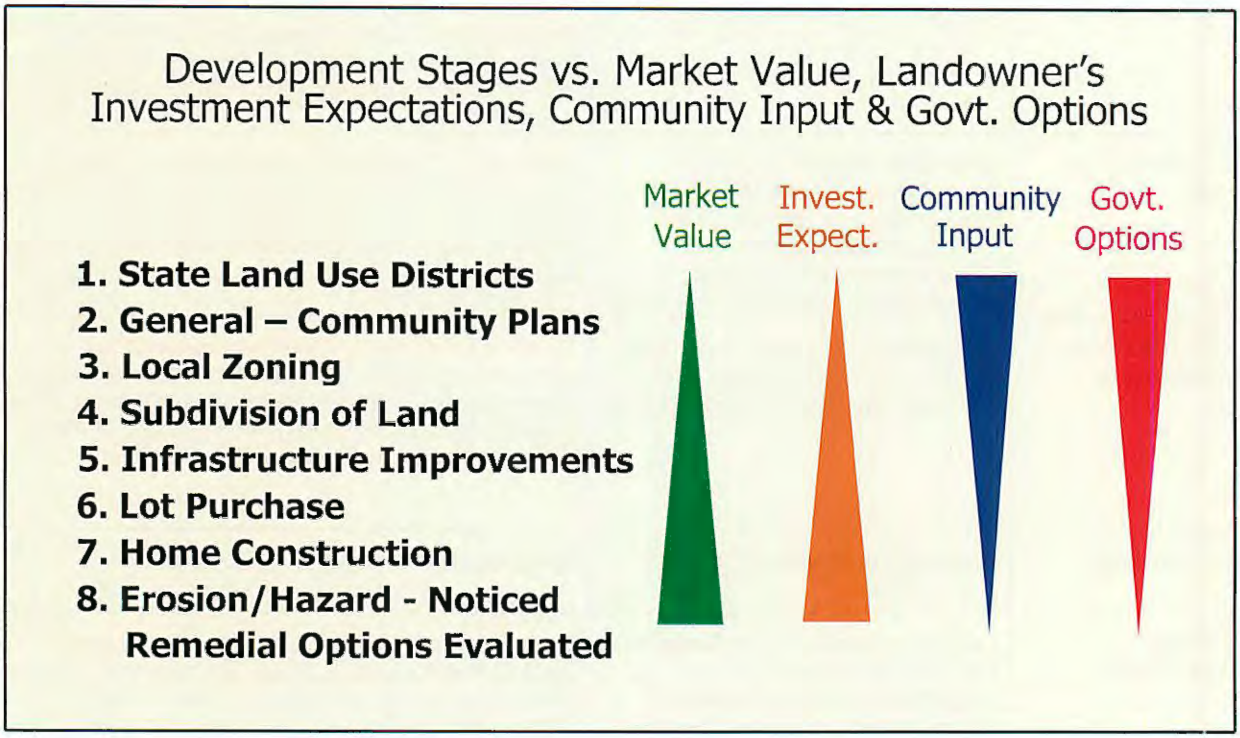

Figure 2-5 – Stages of Development Versus Impact on Property, Landowner, Community and Agencies - Generalized comparison of market value, reasonable investment-backed expectations of the landowner, power of the community to provide input and available government options as a project passes through the different development stages. The ability of the government to mitigate or plan for coastal hazards diminishes significantly with each stage of development in which the issue is ignored. Generally, coastal hazards should be addressed at the earliest land use opportunity (i.e., the earliest development stage in which a project is up for approval). Ideally, these issues should be addressed at the district classification, general & community planning, zoning and subdivision stages.

If coastal hazards such as erosion are addressed too late, for example after the subdivision stage, small lots may be created which may not allow implementation of a scientifically based setback and protection of the property rights of the landowner. The option to purchase the property may be foreclosed if the land becomes too expensive by this time. An early hazard assessment allows problem areas to be identified quickly, so that counties can make the decision to purchase when areas are designated for less expensive low density use, instead of when they may be approved and improved for high scale single family residences.

Another common land use option to protect coastal areas is for the landowner to swap land for similarly valued properties owned by the public. However, waiting until the land grows significantly in value is likely to diminish suitable properties that the public can swap with the landowner.

As illustrated in Figure 2-5, as the landowner invests more time and money into the project with each stage of development, the "reasonable investment-backed expectations" of the landowner grow proportionately. By investing more resources into the project, the landowner is likely to assert that they have a vested right to develop to a certain level. These concepts in property law relate directly to the authority of the government to regulate land.

The government can regulate land uses for the health, safety and welfare of the public, but at some point, regulations can be deemed a "regulatory taking" and require compensation under the fifth amendment of the U.S. constitution (see Appendix D). To determine if a regulation has gone too far, the courts will balance: (1) the government purpose or character of the government action with (2) the economic impact on the landowner and (3) the extent the regulation interferes with investment-backed expectations of the landowner.[6]

Addressing coastal hazards at the early stages of development with a safety setback is likely to have much less impact, economically and on the reasonable investment-backed expectations of the landowner. Thus, hazard mitigation planning in the initial stages of development minimizes the burdens on the landowner while greatly reducing any possibility that there will be a legitimate regulatory takings claim against the agencies.

The investment-backed expectations of the landowner must be "reasonable." Excessive money spent for a high density subdivision when the land is still classified as conservation would be deemed unreasonable and speculative. However, that same money spent when the land is classified urban at the State level, zoned residential at the county level and designated for a residential subdivision in the general and community plans would be reasonable. A key implementation strategy in this manual is to address

[6] Penn Central Transportation Company v. City of New York, 438 US 104, 98 S.Ct. 2646 (1978); City of Monterey v. Del Monte Dunes at Monterey, Ltd., 526 U.S.687, 119 S.Ct. 1624 (1999).

hazard mitigation before the vested rights and the reasonable investment-backed expectations of the landowner build.

The government has strong authority in its power to regulate land if it is exercising a legitimate government purpose relating to the mitigation of risks from coastal hazards. Numerous cases have indicated that the objective of protecting life and property from natural hazards is perhaps, the greatest of all government purposes. Given the strong authority of the government to reduce the risks from natural hazards, coupled with early planning, the likelihood of a successful takings claim is expected to be low. Nevertheless, the agencies should strive to minimize the burden on landowners by addressing coastal hazards as early as possible in the development process and by pushing for innovative and flexible design, which will reduce any economic impact.

In column 3 of Figure 2-5, the community's desire to keep sensitive or hazard areas open space will carry much weight at the early stages of development, provided that the risk of coastal hazards is assessed. Conversely, the same community desire would receive little attention after the land is subdivided, the infrastructure is in and the new landowner is about to construct a house (Stage 7). This illustrates the need for community groups and neighborhood boards to be active in the initial stages of development, if they want their opinions to be seriously considered.

In the final column of Figure 2-5, the government's options to address coastal hazards clearly dwindle with each stage of development that a project passes through. The government will be increasingly prevented from acquiring land, promoting land swaps, fostering creative project design, utilizing innovative land use tools, or employing its police power to implement technically based setbacks, as each development stage proceeds while the issue of coastal hazard mitigation is ignored. Therefore, it is important that a government agency not pass a legitimate hazard mitigation issue down the development chain when there is an opportunity to address the issue proactively.

It would also be important that agencies coordinate their hazard mitigation efforts in a horizontal sense (within the same stage of development) and vertical sense (at different stages of development). This will serve the multiple purpose of: (1) ensuring that development policies are consistent throughout the county, (2) redundant review is eliminated, (3) permitting is streamlined, and (4) economic impacts are minimized.

Figure 2-6 shows where in the development process proper siting (as opposed to correct construction practices) should be addressed.[7] Generally, siting issues should be

[7] For this manual, the term "siting" is used broadly and includes approvals directly affecting the location of buildings, such as a building permit, and land use decisions indirectly affecting where structures are later placed. For example, the Land Use Commission (Stage 1) or County Councils (Stage 3) may designate an area unsuitable for a certain use because of exposure to hazards. This decision propagates down the development chain and can later affect the siting of structures during Stage 7. See Table 2-1 for applicable agencies at each Stage.

addressed from Stages 1 through 7 while construction methods are addressed primarily at Stage 7. The later siting issues are addressed in the development process, the more likely that siting will be based on political or convenience standards as opposed to objective or technical standards. As pointed out in the FEMA CCM, improper siting will undermine efforts to build correctly.

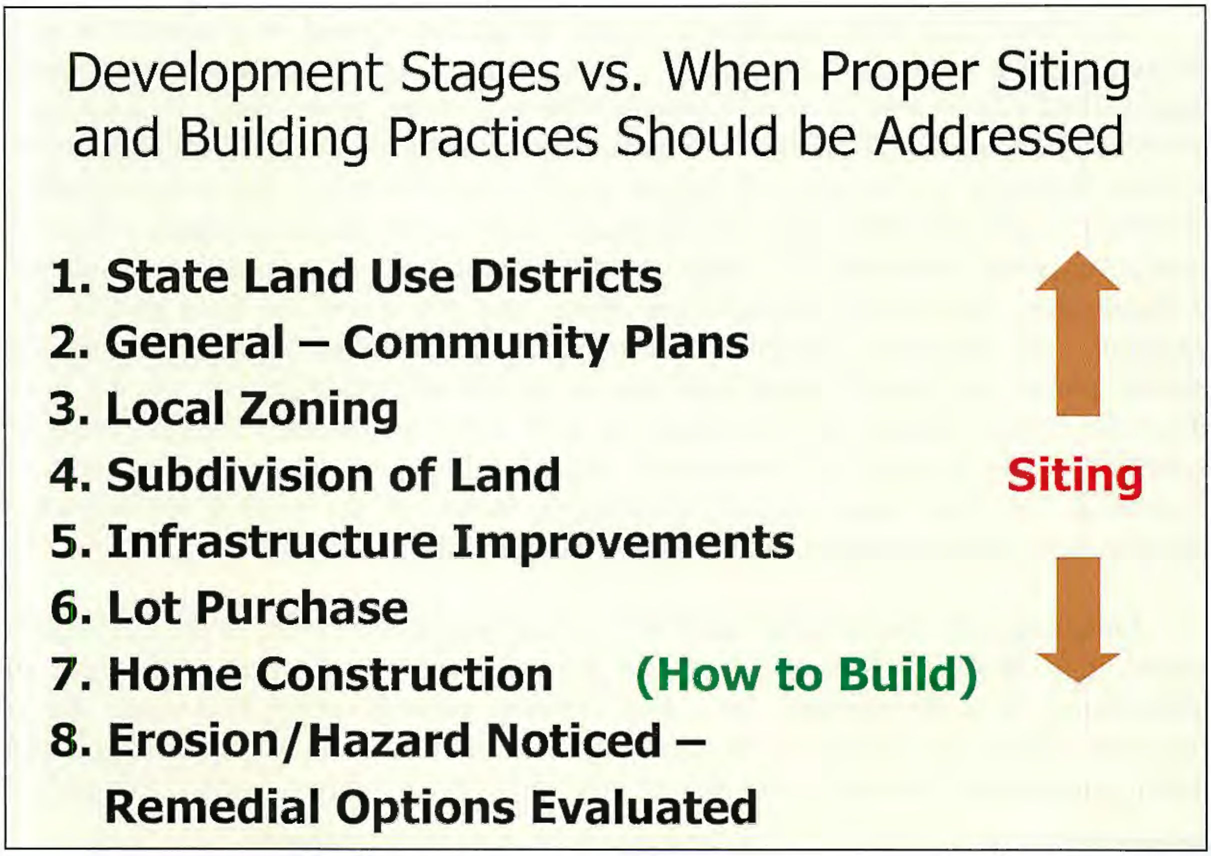

Figure 2-6 – Development Stages Versus When Siting and Building Issues are Addressed - Siting correctly and building correctly are the two keys to the proper mitigation of coastal hazards. For legal, political and practical purposes, siting issues should be addressed as early as possible in the development process (stages 1 through 4). Siting at stages 5 through 8 may be done correctly, but is likely to be improper due to prior development decisions that become irreversible. Building correctly can be done at Stage 7. See footnote 7 on definition of siting.

From a purely physical point of view, the subdivision stage (Stage 4) is critical to address coastal hazards. If hazards such as erosion are not factored during subdivision, then small lots may be created along the coastline that will not be able to accommodate these hazards. Poorly planned lot development will lead to future homeowners being exposed to numerous hazards and the certainty that mitigation measures may be imposed piecemeal.

Political and fairness considerations, however, may require that the issue of hazard mitigation be addressed much earlier than the subdivision stage. As illustrated in Figure

2-5, considerable time and money can be spent on a project to obtain district classification or zoning changes, to design elements in accordance with existing community plans, or to prepare preliminary schematics prior to final subdivision approval. These expenditures are often used by the landowner to assert that they have built up an investment-backed expectation and vested interest in the project as designed.

To circumvent these assertions, hazard mitigation should be planned for at the earliest available land-use opportunity. Therefore, an appropriate time to implement detailed standards on how to avoid hazard problems is when general or community plans are amended (Stage 2). Similarly, if there is a district reclassification at the State level or a zoning change at the local level (Stages 1 or 3), the instability of the area should be considered so that the subject lot can adequately support the intended change. If a lot is up for subdivision (Stage 4), it is suggested that hazards such as erosion be considered at the preliminary design and consultation phase, and not when the final plat is being evaluated. The time and cost difference between the preliminary design and the final approval phase for a large subdivision can be significant and therefore, coastal hazard mitigation issues should not be raised a year after preliminary design work has proceeded. The concept of addressing hazard mitigation at the earliest land use opportunity (i.e., the earliest development stage) factors in the goal of this manual, to minimize the economic impact to the regulated community.

Generally, erosion hazards need to be considered much earlier in the development process than flooding hazards, because erosion can change the actual size and configuration of a developable lot. For flooding hazards along the coast, the key mitigation stage is generally at the time of home construction, when the appropriate building methods can be utilized to elevate structures above the flood water (Figure 2-7).

Figure 2-7 – House Above the Base Flood Elevation at Haena, Kauai - Many of the flooding issues associated with coastal storms, tsunamis or hurricanes can be addressed at Stage 7, by elevating the house so that the lower floor is above the 100-year flood water levels (i.e., the base flood elevation). A margin of safety can be built in by constructing a few feet higher than the BFE.

2.2 Homeowner - Consumer Protection

Homeowners have expressed concern about the large wave, the severe storm or rapid erosion that threatens the integrity of a home and undermines their building. Often, these concerns are not raised during the purchase of coastal property, but after a family moves in and experiences living near the ocean every day for many years.

Generally, the landowner, developer and agencies will be more cognizant of the risks of coastal hazards and in a much better position to address the problem as opposed to a layperson interested in the purchase of a coastal home. Comparing the financial resources of the parties, and the estimated costs for an erosion study by the developer versus the costs of the study and remedial measures for the homeowner, it is generally a much greater burden for the homeowner to deal with the problem after the fact.

This manual distinguishes between the landowner/seller and the homeowner/buyer and emphasizes the importance of homeowner - consumer protection. By implementing measures to reduce coastal hazard risks, the landowner/developer provides a safer and more valuable product to the consumer, the ultimate homeowner. Just as developers in Hawaii address termite and hurricane risks before selling new homes, they should also plan to mitigate risks from coastal hazards such as erosion, and not pass this problem onto future buyers. Consumer protection is advanced when buyers of coastal lots and homes are fully aware of the potential risks of coastal hazards for their particular lot.

Real estate disclosure laws play an important role in ensuring that purchasers are fully informed. With a knowledgeable buyer, it is to the economic benefit of the developer to build better homes that factor in potential coastal hazard risks. Consumer protection and disclosure laws also introduce an important market element into hazard mitigation design and development.

The purchaser of a lot or a new home should expect that if a property is situated along the coast, it is subject to erosion and flooding risks. The seller of the lot or home should be expected to have addressed the problem. This manual encourages developers to design projects so that the future residents are adequately protected. Erosion and flooding risks should be reduced and the site suitable for its intended use as a dwelling for residents. A design goal for coastal construction is that the homeowner should not have to apply for permits to mitigate shoreline erosion, or harden the shoreline during the lifetime of the proposed structure.

2.3 Community Participation

This manual encourages the community to participate by providing the public a reasonable framework for input. For example, guidance is provided for when in the development process the communities' input on a coastal project carries the most weight. The neighborhood boards and community in general are encouraged to actively participate in the creation or amendment of general, development and community plans. These plans are later factored into key land use decisions. The community should also be involved in key zoning and subdivision decisions. However, the later in the development process the community input is received regarding a development project, the greater the chance that it will be outweighed by the interests of the landowner.

2.4 Alleviate Burdens on the Regulated Community

It is also a goal to implement hazard mitigation measures in a manner that is the least burdensome to government agencies and the regulated community. By minimizing potential burdens, the strategies for implementation have the greatest chance of obtaining a broad based level of acceptance.

Early planning for hazard risks alleviates the impact of the mitigation measures on the regulated community by providing the earliest possible notice of a major design consideration. With early notice, there is opportunity for stake holders and the agencies to create innovative designs that reduce the risks of hazards and allow economic development. By taking into account the concerns of the regulated community, it is more likely that the measures proposed will gain political acceptance and be implemented in the field. Measures that are unduly harsh, burdensome or unfair are not likely to find acceptance with key decision makers and therefore, will be of no practical value. While it is possible to minimize the burden on the regulated community, there will nevertheless be some additional costs in hazard mitigation. However, developers should consider that when coastal hazards are addressed in project design, the end product will be more valuable to a knowledgeable prospective buyer.

Where possible, measures are suggested to streamline approvals while providing for a more robust analysis of the coastal hazard issue. For instance, default values are provided for some of the parameters in the formula to determine the erosion zone (Chapter 4). This will help to alleviate the burden of the erosion study. Another measure to reduce regulatory burdens is to provide guidelines on three different levels of hazard assessment that are appropriate for the different development stages (Section 4.6).

Moreover, mitigation measures for different hazard risks are categorized as siting or construction related. This insures that parties dealing with a zone change do not have to worry about construction issues, such as the wind forces and loads on a building. Many of the issues related to construction generally do not need to be analyzed in detail in the hazard assessment.

Finally, the majority of measures that are proposed in this manual as a standard have been successfully implemented to some extent in Hawaii. Examples of the measures or designs are provided in Figures to demonstrate their technical viability or economic feasibility.

2.5 Multi-Hazard Mitigation Benefit

This manual is designed to provide guidance on how erosion and flooding problems can be avoided for all stages of development. Since coastal hazards overlap, mitigating the risks from erosion and flooding in general will reduce the risk from erosion and flooding associated with hurricanes and tsunamis. Therefore, there is likely to be a multi-hazard mitigation benefit from implementation of the strategies in this manual.

This manual stresses the importance of the multi-hazard mitigation benefit derived from planning for coastal erosion and flooding. With proper coastal design and construction, the impacts from many coastal hazards can be simultaneously reduced. In terms of factors that government agencies must weigh, the protection of fellow citizens and property from natural hazards should receive the highest priority and is a strong justification to implement the measures in this manual.

2.6 Environmental Protection

In many coastal states, erosion hazard mitigation strategies are being developed to protect beach and public shoreline access. It is expected that measures to mitigate risks from coastal hazards will lead to some environmental benefit in the form of preserved beach systems, improved access and maintenance of water quality. Nevertheless, the driving force in the development of mitigation measures is the need to reduce the risks from coastal hazards.

The fact that the separate government goals of hazard mitigation and environmental protection overlap should serve to reinforce, rather than detract from the need for the planning of erosion and hazard risks.

2.7 Implement Technically Based Standards

The standards in this manual are, to the greatest extent possible, based on objective and technical standards, versus political or social criteria. For instance, the erosion setback formula is based on an average annual erosion rate times a period of 70 years (Chapter 4). The 70 years is not based on subjective factors, but a nationwide study conducted by the Federal Insurance Administration, Department of Housing and Urban Development to establish reliable estimates for the life of coastal residential structures (Anderson, 1978).

Technical standards should serve as the design goal for implementation of hazard mitigation measures. Once technical standards are set, regulatory flexibility and creativity can be used to develop implementation strategies that take into account legal, political, economic, environmental and fairness factors to arrive at a more realistic and balanced decision. Although many implementation strategies are provided in the guidebook, it is up to all stakeholders to analyze, utilize and/or improve these measures.

The safety buffers herein provided are potentially the largest of any previously proposed in Hawaii, since they are based on technical standards. This is tempered with the strategies in this manual to reduce impact on the regulated community by early planning, innovative design and streamlining of the regulatory process.

2.8 Government Implementation – Light or Heavy Handed?

Government agencies can implement their programs using a light or heavy handed approach. The heavy handed approach is based on new regulations, additional program elements and enforcement. The light handed approach is based on the utilization of knowledge, information and guidance in order to shape new policies, create industry standards and work within the existing regulatory framework (Figure 2-8).

An objective of this manual is to provide guidance to address erosion, flooding and other coastal hazard issues. Guidance helps to implement a light handed approach to hazard mitigation by linking information for planning with the utilization of industry standards, policy and existing regulatory authority. Interviews with county planners indicated that the light handed approach has the greatest chance of obtaining widespread support.

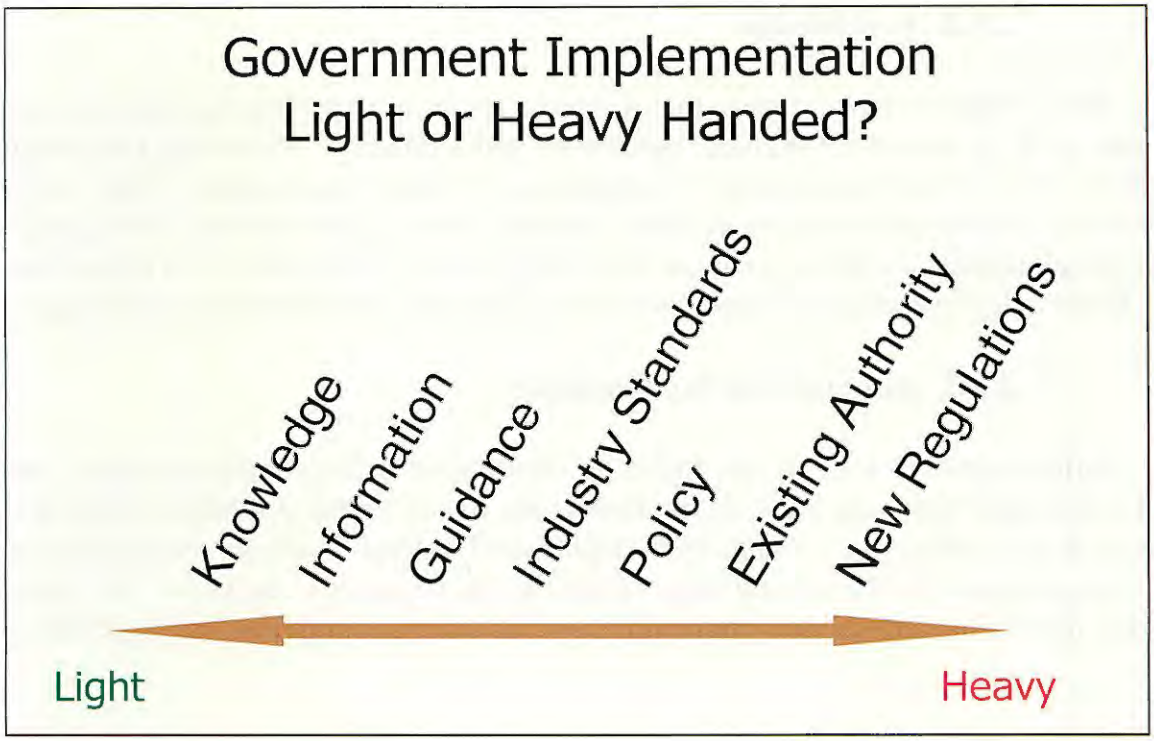

Figure 2-8 – Government Implementation – Light or Heavy Handed? Government decisions are based on a continuum of elements. At the core is knowledge that coastal hazards may impact development. Next is information needed for planning, such as coastal erosion data. Guidance is necessary to determine how to deal with different scenarios. The agencies can use guidance to develop industry standards, turn it into policy, or utilize it within their existing regulatory authority. As a last resort, new regulations may be needed.

Generally, the measures in this manual can be implemented within the existing regulatory framework or by developing industry standards and policy, instead of relying on new regulation. The counties, dependant on their own political environment can decide how they want to implement the guidance. In the rare instance where new rules or statutes are felt to be needed, it is discussed in this manual.

The light handed approach is felt to be the most flexible, which is appropriate considering the diverse State and county agencies involved with development decisions (Table 2-1). Within each of the agencies, there would be different hazard mitigation issues, regulations, policies and practices, as well as varied political persuasions and personalities. The guidebook provides opportunities and tools for governing agencies to implement strategies to reduce erosion and flood hazards at all stages of development. The extent to which an agency wishes to address these matters is up to them, whether light or heavy handed, or somewhere in between.

It is important to review each of the different elements of government decision making as depicted in Figure 2-8.

2.8.1 Knowledge

Knowledge is an awareness that a development project may be subject to coastal hazards, such as erosion, flooding, hurricanes and tsunamis. With that knowledge, it would be the normal progression to determine if there are potential risks to future inhabitants. While knowledge is the basic building block in the decision making process, many development decisions are made with little or no investigation of a coastal hazard risk. Knowledge of a potential problem leads to obtaining information for planning.

2.8.2 Information for Planning

Information, as used in this report, is information sufficient for planning. Once it is acknowledged that there is a risk, analysis of the extent of the problem is called for. At the core of the analysis is a hazard assessment (see Chapters 3 and 4). At the core of the hazard assessment, for the coastal areas of Hawaii, is the erosion analysis. The emphasis on other natural hazards is likely to be different for other geographical areas and for other states.

In the case of coastal erosion, the historical shoreline positions may be analyzed with aerial photographs to determine a likely erosion rate and the erosion hazard zone. This data can then be used to design the proper size of lots in a subdivision so that future homeowners are not threatened. Information for planning is vital and is available from numerous sources (see Appendix A). If the data is not available or outdated, the owner/developer could hire a consultant to obtain the needed information (Appendix B). Hiring a consultant is a standard practice for the assessment of environmental issues in a project, such as for noise, traffic, or drainage. Consultants can follow established standards agreed to by the agencies (Chapter 4) so that the erosion analysis is uniform and unbiased.

The need of data for coastal planning is so great that the State or counties should consider conducting, on an island wide basis, erosion studies similar to what was conducted on Maui County (see Figure 4-2). This data alleviates the need for private parties do to an erosion study and also provides planning information for State or county projects near the coastline. If this data is not available for an area, it could be the proponent of a development project that obtains it. Coastal development that proceeds in a vacuum of planning information may expose future inhabitants to unnecessary risks.

2.8.3 Guidance

With information suitable for planning, guidance can then be provided to help reduce hazard risks for different development scenarios. The thrust of guidance in this book is to offer strategies and explanations on reasonable and appropriate hazard mitigation measures that can then be discussed, improved upon or implemented. For example, suggestions are offered on: (1) how is the erosion zone determined, (2) what should be the planning period for certain development projects, (3) what is the life expectancy of different structures, (4) when in the development process should erosion be addressed versus flooding or wave inundation, (5) factors that should be considered in changing the zoning of land, (6) hazard mitigation elements that should be in a general or community plan, (7) how projects can be designed during a subdivision to minimize the risk from coastal hazards while maximizing economic use, and (8) disclosure laws that apply to the transfer of property. Topics such as these are covered in various portions of this guidebook.

2.8.4 Industry Standards

An efficient way to implement the measures in this manual would be to establish the recommended practices as local industry standards without government regulation. Industry standards develop over time. Once established, members in the industry follow the practice even though there may be no rules on the matter. There are at least three ways that government can facilitate the development of guidance into industry standards. First, this guidebook, or portions of it can be adopted as policy. Second, agencies can expedite the formation of industry standards by using this manual to guide development decisions within their existing regulatory authority. Finally, the government can facilitate development of industry standards by outreach to targeted industries and the public, coupled with encouragement for utilization of this manual. This third approach would be based heavily on education and, initially, on voluntary implementation within the industry.

The public can help to create industry standards by becoming active in future development decisions along the coast, especially during the early stages of development (Figures 2-5 & 2-6). In particular, neighborhood boards and communities should be involved in any amendments to general or community plans (Chapter 6). Expression of support for hazard mitigation measures, such as found in this guidebook or elsewhere, would be important during the early stages of development when land use approvals for district reclassifications, zoning changes and subdivisions are being sought.

Most importantly, the planning, architectural, real estate and development industry can foster the adoption of industry standards. Within these groups, there is likely to be mixed reviews to the hazard mitigation measures in this guidebook. Nevertheless, the corporate responsibility of businesses in Hawaii should not be underestimated. Many developments have been proactive in designing for contingencies such as termite infestation or hurricane wind damage so that future homeowners would not have to deal with the problem when it would be more expensive. This philosophy can carry over to implementation of the hazard mitigation measures in this guidebook. Taking the effort to build safer and better would ultimately reduce potential liability on developers and enhance the developer's reputation. With full and proper disclosure, the housing would be more valuable.

2.8.5 Policy

Policy refers to the general principles by which a government is guided in its management of public affairs. Agencies can adopt policies that guide the interpretation of existing regulations or laws. As an example, an agency may have a policy that this manual, or certain portions should be followed to meet the objectives and policies of the Hawaii Coastal Zone Management Act. For instance, under the CZM Act, Hawaii Revised Statutes § 205A-2, it is an objective to: "Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence and pollution."

This manual by itself is not official policy. Specific and discrete action by the State or county agencies would be required to elevate the guidebook or particular measures within to such a status. Another alternative is for the agencies to encourage developers to use the measures in this manual in order to establish them as an industry standard, without creating official policy.

2.8.6 Existing Regulatory Authority

For the most part, the guidance in this manual is designed to be implemented within the existing regulatory and statutory authority of the State and local government. This will be discussed in the review for each of the eight development stages. This strategy was viewed to have the greatest chance of gaining widespread acceptance and is part of a light-handed government approach to implementation.

2.8.7 New Regulations

There is only one stage of development in which an attempt to implement a technically based setback standard may warrant new regulations. In Chapter 11 on home construction (Stage 7), the possibility of new regulations for a shoreline setback is discussed for the siting of structures on pre-existing coastal lots. New regulation may be needed at this stage to provide the landowner or future homeowner adequate notice, since it is so late in the development process. Nevertheless, numerous suggestions are offered in the Chapter so that if there are new regulations, the burdens on the affected parties can be minimized to the greatest extent possible.

Chapter 3 – The Relationship of Erosion with Other Coastal Hazards

Different portions of Hawaii are subject to different coastal hazards, including coastal erosion, bluff erosion, flooding, tsunamis, hurricanes, wind, lava, landslides, subsidence and earthquakes. A detailed compilation of natural hazards in Hawaii is found in the report "Atlas of Natural Hazards in the Hawaiian Coastal Zone," (Fletcher et. al., 2002). This report should be referred to in order to assess the risks of each of these hazards for different coastal areas in Hawaii.[8]

For any hazard assessment, it is standard procedure that all potential hazards in an area be reviewed to determine the likely impact on a property. Once the assessment is complete, the next major question is whether hazard mitigation should be implemented during the siting stages of development or the construction stages (Figure 2-6). This is partly a political question but also turns on how well the hazard can be mitigated solely through proper construction measures.

To help address this issue, Figure 3-1 depicts the zonation of erosion and other hazard forces in relation to the coastline (adapted from Texas Coastal and Marine Council, 1976 & FEMA CCM). Closest to the coastline is the erosion zone, which is subject to wind, flooding, wave action (battering), scour and erosion. Coastal erosion is a hazard that should be mitigated during the siting stages of development. The erosion zone is a combination of chronic and seasonal erosion and may extend several hundred feet inland depending on the time frame of consideration. On rocky shorelines, however, the erosion zone will be very narrow. Guidance for determining the erosion zone in Hawaii is provided in Chapter 4.

The wave zone is generally farther inland and subject to wind, flooding, and wave action. However, on shorelines with a high bluff, the erosion zone may be further inland than the wave zone. The wave zone coincides with V and VE Zones established by the National Flood Insurance Program and is subject to flooding and high velocity wave action. The inland extent of the wave zone is expected to be much greater than the erosion zone. For example, on December 1-4, 1969, large winter waves generated from a tropical storm in the North Pacific eroded the vegetation line at Waimea Bay on Oahu an estimated 50-60 feet, while inundation, as indicated by rocks and sand was more than 750 feet inland (State of Hawaii, DLNR, 1970). According to Flood Insurance Rate Maps for Honolulu, the wave or VE-zones on the north shore of Oahu are about 200 feet for Sunset Beach, 700 feet at Kawela Bay and about 1000 feet inland at Kahuku.

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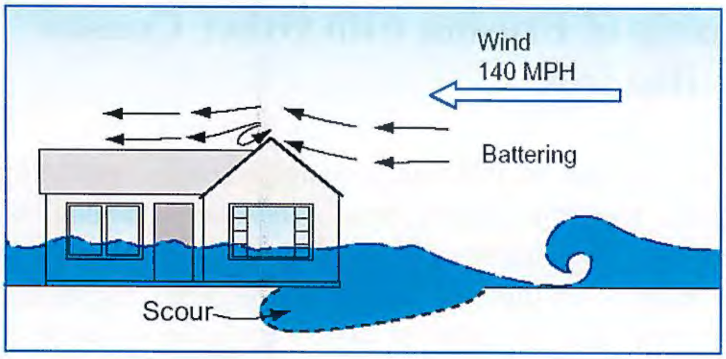
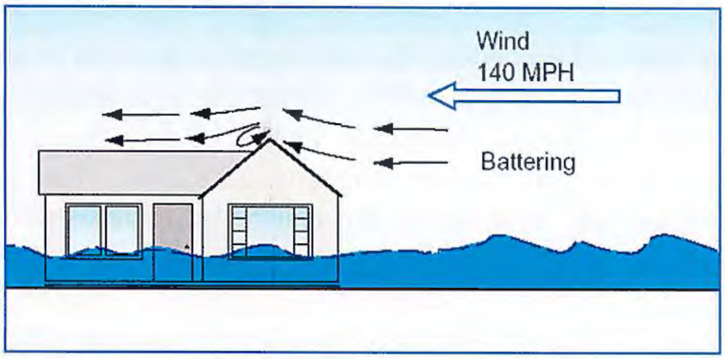
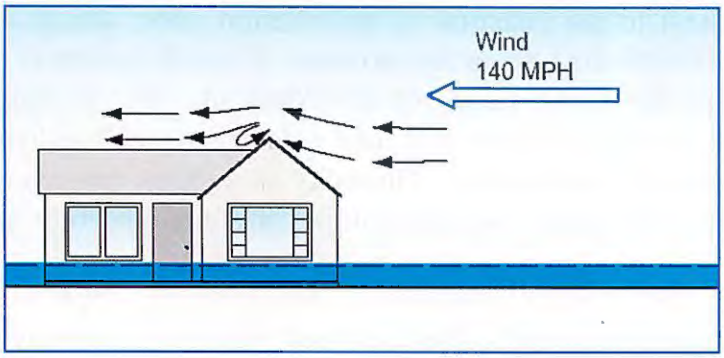
[8] It may be found online at http://pubs.usgs.gov/imap/i2761/



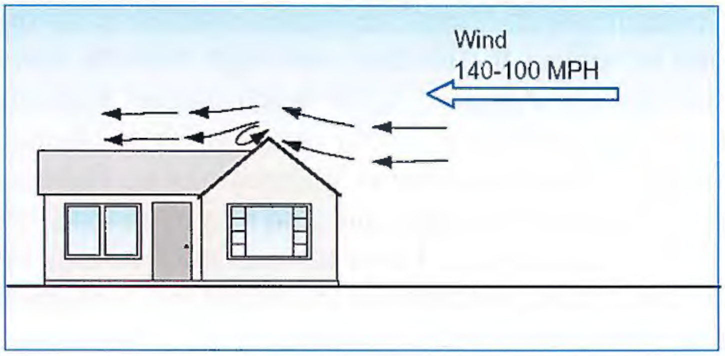
Erosion Zone - Closest to the coast is the erosion zone, subject to wind, high velocity wave action, flooding, scour and erosion. It is suggested that erosion zones be avoided during development because the issue cannot be satisfactorily addressed during the construction stage. Hazard mitigation planning for development in erosion zones should be primarily during the siting stages of development.



Wave (V-VE) Zone - Farther inland is the wave zone (FEMA's **V** and VE zones). This zone is subject to wind, flooding & high velocity wave action. Suggestions have been made to avoid development in the V-zones. Hazard mitigation in V-zones should be addressed during the siting and construction stages, but in Hawaii, has been addressed primarily during the construction stage.



Flood (A-AE-X) Zone – Even farther inland is the flood zone (FEMA's A, AE, and X zones) subject to wind, flooding & possibly lesser wave action. Mitigation in this zone would require elevation of the lowest floor members above the BFE. It is hard to predict how far inland wave action will be felt. The FEMA CCM recommends treating A zones in the coastal zone as V zones.



Inland Zone - Farthest inland and away from the coast, structures are subject primarily to wind action. For development away from the coast, hazard mitigation is expected to rely more on construction methods rather than siting measures. Wind speed has diminished in intensity as expected for inland properties. Nevertheless, localized topography can amplify winds, even in inland areas.

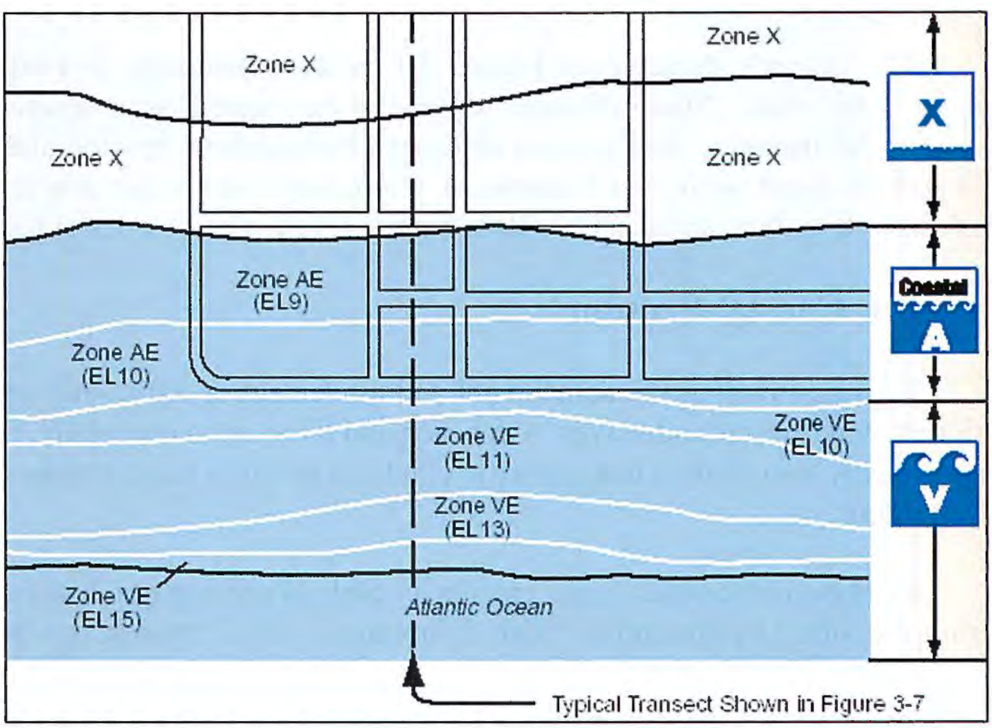
Figure 3-1 – Generalized Schematic Representation of Hazard Zones - This diagram shows the spatial relationship of coastal erosion with other coastal hazards and illustrates the importance of planning for coastal erosion to mitigate the risks from other hazards. Adapted from Texas Coastal and Marine Council 1976 & FEMA CCM.

Farther inland is the flood zone, which coincides with FEMA's A, AE, or X zones. The flood zone is subject to flooding and wind action. Low velocity wave action, may also be present. From the FIRMs for the North Shore of Oahu, the AE zone is about 500 feet inland at Sunset Beach, over 1,200 feet at Kawela Bay and over 6,000 feet at Kahuku.

Farthest inland, and essentially away from the coast, is the inland zone, which is subject to wind stress. Since this area is inland, it is expected that hurricane winds would be diminished in intensity. Flooding should not be a problem unless the area is near a stream or floodplain.

There are two advantages to designating hazard zones as depicted in Figure 3-1. First, the information to delineate the wave (V-VE), flood (A-AE-X) and inland zones has already been calculated by FEMA for their flood insurance program and appears on Federal Insurance Rate Maps ("FIRMs") (Figure 3-2). The second major advantage is that in Hawaii, the Flood Insurance Studies and the flood zones on the FIRMs are based on tsunami inundation data, and in some localities, data from Hurricanes Iniki and Iwa (See Chapter 4). Thus, there is a multi-hazard mitigation benefit in planning development around the FIRMs.

Figure 3-2 – Federal Insurance Rate Map – FIRM shows the location of the VE, AE and X zones. The numbers in parenthesis are Base Flood Elevations. The VE and AE zones constitute the Special Flood Hazard Area. The coastal A designation originates from the FEMA CCM, 2000.



Development in the erosion zone should be addressed during the siting stages of development (Figure 2-6). Because the wave zones in Hawaii are likely to be relatively large, it may be politically difficult to avoid these areas entirely, and thus hazard mitigation may need to rely on construction measures (Figure 2-7). Depending on how protective the counties are, development in the wave zone could be addressed during the siting stages. With a proper hazard assessment, it should be possible to determine if sufficient hazard mitigation measures can be implemented during construction to address impacts in the wave zone. Development in the flood or inland zones would, in general, rely on construction measures for hazard mitigation. The exception would be for critical facilities such as hospitals, schools, shelters and their associated infrastructure.

Generally, a hazard assessment should address all hazards as early as possible in the development process, even though implementation of mitigation measures for a particular hazard may not be needed until the construction stage. This, however, may not be known until the hazard assessment is completed. The assessment may reveal that a particular hazard should have been addressed earlier in the development process.

Note that the erosion zone in Figure 3-1 is closest to the coast and subject to the most intense and varied forces of nature. For example, the winds are generally stronger, the flooding higher and the waves more powerful nearer the coast. Furthermore, there are erosive, scour and wave forces acting in the erosion zone that are not in the inland or flood zones. With each zone that is closer to the coast, the requirements become more stringent on siting and construction. Thus, it becomes more important to address hazard mitigation earlier in the development hierarchy (Figure 2-6).

The hazards depicted in Figure 3-1 relate generically to erosion, wave action, flooding and wind. Many of these forces can be created from several different natural hazards. For instance, flooding can be caused by long-term erosion and wave inundation, or a sudden event such as a tsunami, or storm surge and wave action associated with a hurricane. It is thus necessary to relate Figure 3-1 to specific coastal hazards in Hawaii.

3.1 Coastal Erosion

Erosion involves the detachment and movement of rock, sand and soil through the action of wind, water and waves. On beach and dune areas especially, the unconsolidated sand is easily moved by wind and waves and can result in rapid changes in the position of the shoreline.

In Hawaii's coastal zone, erosion is probably the major hazard to be considered during the siting of structures. This is because coastal erosion can quickly change the size of lots. This fluctuation is in direct conflict with development, which assumes a degree of boundary stability that is not existent on sandy shorelines. For example, zoning decisions relate to the density of development, or the number of units in a given area. This in turn relates to the size of the lots on which structures are built. Coastal erosion can change the size of the lots and thus, undermine the basis for the designated zoning.

From a practical point of view, erosion can be planned for by determining how the shoreline has changed in the past. The common method of dealing with erosion - - safety setbacks -- can be structured to be politically acceptable if it is early in the development process and balances, to the maximum extent possible, the concerns of affected parties. Anytime there is coastal development along a sandy shoreline, the issue of siting should factor in the risk of coastal erosion. A coastal erosion zone is recommended (Figure 3-1) that considers the rate of erosion, the life expectancy of proposed structures and a safety buffer.

Further discussion on determining the critical erosion zone is provided in Chapter 4. Key references that will assist in the planning and assessment of risks for coastal erosion are found in Appendix A of this report.

3.2 Bluff Erosion

Most coastal bluffs at beaches in Hawaii consist of steep vegetated dune systems, although many other types of shorelines are characterized by earthen and rocky bluffs (Fletcher, et al. 1994). Erosion of the bluff may occur when wave action removes the unconsolidated sediment at the base, which in turn undercuts the overlying portion of the dune and vegetation. Bluff erosion is very difficult to control and may undermine structures built near the bluff edge.

As with coastal erosion, bluff erosion is viewed as a hazard that should be addressed during the siting and construction stages. Bluff erosion will cause lots to change in size and there may be few options in the construction stage that would mitigate the hazard once structures are placed too close to an eroding bluff.

One distinction between bluff erosion and coastal erosion is that because of the height of bluffs, the risk of flooding associated with wave inundation is less. Bluff erosion has not been well studied in Hawaii. Hence, the nature of bluff failure, whether it is chronic or catastrophic is not well understood.

Bluff erosion should be readily identifiable by a site visit (Figure 3-3). For coastal areas experiencing bluff erosion, the extent of the zone should be based on the rate of erosion, the life of a proposed structure and an adequate buffer zone. The extent of bluff erosion should help to determine the erosion zone as depicted in Figure 3-1.

3.3 Coastal Flooding

Coastal flooding is distinguished from inland or urban flooding, although stream flooding can be of importance where streams reach the coastline. Although inland and urban flooding are outside the scope of this manual, the concepts developed herein can be used to mitigate the damage from these particular hazards.

Figure 3-3 – Bluff Erosion - Waihee Beach, Maui - During a hazard assessment, bluff erosion is readily identifiable by trees on the beach, an erosional scarp and roots exposed at the top of the bluff.

There are several major causes of coastal flooding unrelated to stream or inland flooding. First, tropical storms, hurricanes and intense offshore low pressure systems can drive ocean water inland by storm surge and/or large waves that flood property (Figure 1-10)(Hawaii Hazard Mitigation Forum: Mother Nature, 2002). Second, coastal erosion can bring structures within the reach of breaking waves and also flood property (Figure 1-11). Finally, tsunami runup can cause inundation and flooding of coastal properties.

Mitigation of coastal flooding from large storm waves has traditionally been addressed at the construction stage rather than the siting stages of development for several reasons. First, mitigation from the impact of flood waters and wave action can be achieved by elevating structures above the base flood elevation (Figure 2-7). The second reason that flooding is viewed as a construction issue is that the National Flood Insurance Program ("NFIP") does not require a specific setback for new development along water bodies. Instead, specific building standards are required to mitigate the impact from flooding. Communities allow development within flood prone areas; subject to these building standards and regulations (Oregon Department of Land Conservation & Development, 2000). Finally, the inland extent of the flood zone is likely to be much larger than the erosion or wave zone (Figure 3-1). For example, when Hurricane Iniki hit Kauai, the inland extent of inundation on the south shore of Kauai was over 1,500 feet inland. Although the goal is to avoid flooding areas, from a practical, legal and political viewpoint, it would be difficult to prohibit development over such a large area. This is especially true if the area is partly developed. If the flood prone area is not avoided, then measures during construction would be needed to alleviate the hazard risks.

There are exceptions to when flooding can be addressed during the construction stage of development:

1. Coastal development near beach areas that are adjacent to streams draining to the ocean. If there is a history of stream channel migration, development nearby may subject inhabitants to potential stream erosion, which would undermine efforts to build correctly. This would require special siting considerations.

2. Development in shoreline and flood areas that are subject to short or long–term coastal erosion. The introduction of erosion requires mitigation to be addressed in the siting stages of development.

3. Development of critical facilities and their supporting infrastructure should be avoided where flooding is likely to occur. This would include development in the erosion, wave and flood zones (Figure 3-1). Critical facilities are the essential facilities that provide emergency support to the community and include hospitals, police and fire stations, power generation plants, waste disposal facilities, schools, and evacuation centers (Figure 3-4).

The hazard assessment should determine if there are site specific conditions that would require flooding to be addressed at the siting stages, as opposed to the construction stages of development. A history of high flooding, unusual bathymetry, gently sloping topography and/or a general inability to mitigate the problem during the construction stage may require earlier planning of this issue. Consideration should be given to the ability to mitigate flooding or inundation risks in the wave zone (Figure 3-1) utilizing only construction methods.

Valuable resources to identify areas of flooding and assist in the planning and assessment of the risk are: (1) the FIRM maps for each coastal area, located at the respective county agencies that administer building construction permits (Table 2-1 – row #7 on Home Construction – column 3); (2) the FEMA Coastal Construction Manual, (2000); and (3) the Atlas of Natural Hazards in the Hawaiian Coastal Zone, (Fletcher et al., 2002).

3.4 Tsunamis

A tsunami is a series of waves generated by a sudden movement of the seafloor that displaces a large volume of water. Tsunamis may be triggered by submarine earthquakes, submarine volcanic eruptions, underwater landslides or slumps of large volumes of earth, and onshore slope failures that fall into an ocean.

Tsunamis can be generated by local seafloor motion such as occur off the south and east coast of Hawaii County or by seafloor motion thousands of miles away generated along the rim of the Pacific Ocean. Locally generated tsunamis may present a special problem in that the tsunami can be accompanied with a damaging earthquake. Additionally, the warning time for locally generated tsunamis is minimal, potentially only a few minutes. Tsunamis generated along the Pacific Rim provide more warning time, but historically, have caused more damage in Hawaii.

Critical Facilities

- Emergency Operations Center
- Police and Fire Stations
- City or Town Offices
- Water & Wastewater Plants
- Sewage Pumping Stations
- Schools
- Hospitals
- Day Care Facilities
- Nursing Homes
- Elderly Housing
- Power Substations
- Public Works Garages
- Correctional Facilities
- Shelters
- Hazardous Materials Facilities
- Power Plants
- Access Roads to the Above Facilities

Figure 3-4 - Examples of Critical Facilities - Although it may be possible by engineering measures to mitigate the impacts of flooding on these structures, the need for unimpeded egress and ingress into these facilities justifies, in general, avoiding development in flood prone areas. It is also recommended that, where possible, the development of critical facilities be avoided in tsunami inundation zones (National Tsunami Hazard Mitigation Program, 2001). In Hawaii, tsunami inundation areas have been used to determine the flood areas. This is another example of where the mitigation strategies for two different hazards overlap and support each other.

The most recent tsunamis that have caused damage in the Hawaiian Islands occurred in 1946 (Aleutian Islands), 1952 (Kamchatka), 1960 (Chile), 1964 (Alaska), and 1975 (locally generated from Kalapana on the Big Island). Since 1975, tsunami activity for Hawaii has been relatively quiet when compared to the frequency of historical events.

Some of the major factors that appear to control the risk and potential damage from tsunamis are: (1) the location and magnitude of tsunami generating events, (2) offshore bathymetry, (3) onshore slope, (4) onshore surface roughness, and (5) configuration of the coastline.

Inundation from a tsunami is likely along any coastal area of the State. In some cases, the runup height has been nearly equal on opposite sides of the island. This suggests that while shoreline orientation relative to the tsunami generating event is important, it is not always controlling (Hawaii Hazard Mitigation Forum: Mother Nature, 2002).

Tsunami heights tend to be greatest when the offshore bathymetry is steep. They may be less along gently sloping offshore areas, where wave energy is dissipated by shoaling (Hawaii Hazard Mitigation Forum: Mother Nature, 2002). In terms of run-up onshore, it is the inland slope that also plays a key role. In the Atlas of Natural Hazards in the Hawaiian Coastal Zone (Fletcher et al., 2002), gently sloping inland areas are at greater risks from erosion, stream flooding, tsunami inundation, storm overwash, seasonal high waves and sea-level rise. Another factor is surface roughness in the form of trees, bushes, coastal dunes, or other natural or manmade barriers, which can reduce the inland extent of inundation (See Sections 4.2, 4.4 and 9.3).

Configuration of the coastline is also an important factor. Convex coastlines tend to concentrate tsunami wave energy, while concave coasts tend to dissipate it (County of Hawaii, 1975). There are some localities that have had a propensity for significantly increased tsunami runup and damage such as Hilo Bay in Hawaii. This area was severely damaged by the 1946 and 1960 tsunamis. Hilo is particularly vulnerable to tsunamis because of the orientation of the triangularly shaped bay, which concentrates tsunami wave energy. Mapping of inundation for tsunamis in Hilo indicates that in some localities, the inundation was several thousand feet inland (County of Hawaii, 1975).

Tsunami run-up has been calculated to determine the base flood elevations on the Flood Insurance Rate Maps for the islands of Oahu, Kauai, Maui, Molokai and Hawaii (see also Section 4.2). This run-up information was utilized in determining the inland extent of the V, VE, A and AE zones. Thus, elevating structures above the base flood elevations identified on the FIRMs serves to mitigate the risk from tsunami inundation.

The 2001 report by the National Tsunami Hazard Mitigation Program ("NTHMP") provides seven key principles in planning and designing for tsunamis (Figure 3-5). In the report, the first key principle is to know the areas of tsunami risk and vulnerability. This information can be obtained when a hazard assessment is conducted for a project area.

The Tsunami Mitigation report also acknowledges that development in tsunami inundation areas should be avoided, but when it is not possible because of the large inundation areas, structures should be located, configured, designed and constructed to mitigate future losses. Following the recommendations in the NTHMP report, the planning to mitigate tsunami damage becomes both a siting and construction issue and therefore, should be addressed at the earliest stages of development (Figure 2-6).

Key resources available in the assessment and planning for tsunami risk are: 1) FIRM maps at the respective county agencies dealing with home construction, (Table 2-1 – row on Home Construction – column 3); 2) the Atlas of Natural Hazards in the Hawaiian Coastal Zone, (Fletcher et al., 2002); 3) the FEMA CCM (2000); 4) the report "Designing for Tsunamis – Seven Principles for Planning and Designing for Tsunami Hazards," (National Hazard Mitigation Program, 2001); 5) the companion report

"Designing for Tsunamis Background Papers," (National Hazard Mitigation Program, 2001); 6) tsunami evacuation maps in the local telephone books; and 7) ongoing modeling studies conducted at the Ocean and Resources Engineering Department, University of Hawaii. More detailed analysis of the tsunami risk may be estimated by ascertaining the offshore bathymetry and the inland coastal slope. Computer modeling, historical research, and field confirmation can further help to define potential risks.

Seven Key Principles in Planning and Designing for Tsunamis

1) Know the Community's Tsunami Risk: Hazard, Vulnerability, and Exposure
2) Avoid New Development in Tsunami Run-up Areas
3) Locate and Configure New Development in Tsunami Run-up Areas to Minimize Future Losses
4) Design and Construct New Buildings to Minimize Tsunami Damage
5) Protect Existing Development from Tsunami Losses through Redevelopment, Retrofit and Land Reuse Plans and Projects
6) Use Special Care in Locating and Designing Infrastructure and Critical Facilities
7) Plan for Evacuation

Figure 3-5 – Principles in Planning and Designing for Tsunamis – From the National Tsunami Hazard Mitigation Program, 2001.

3.5 Hurricanes

Hurricanes, tropical storms, and typhoons are collectively known as tropical cyclones. Hurricanes are tropical weather systems with well defined circulation and sustained winds greater than 74 mph. In the western Pacific, typhoons are called hurricanes. Tropical storms are weather systems with a sustained wind speed from 39 to 74 mph. The history of storms in the vicinity of the Hawaiian Islands is depicted in Figure 3-6, which shows the paths of two of the most memorable storms in Hawaii, Hurricanes Iwa (1982) and Iniki (1992).

Since both Iwa and Iniki struck Kauai in recent years, it is wrongly perceived by the general public that Kauai has a greater susceptibility to storm damage. This perception may give agencies and homeowners a false sense of security regarding the risk from hurricanes. Recent studies indicate that hurricane risk for the other islands is just as great, if not greater than for Kauai (Schroeder, 1993; Oahu Civil Defense Agency, 2003).

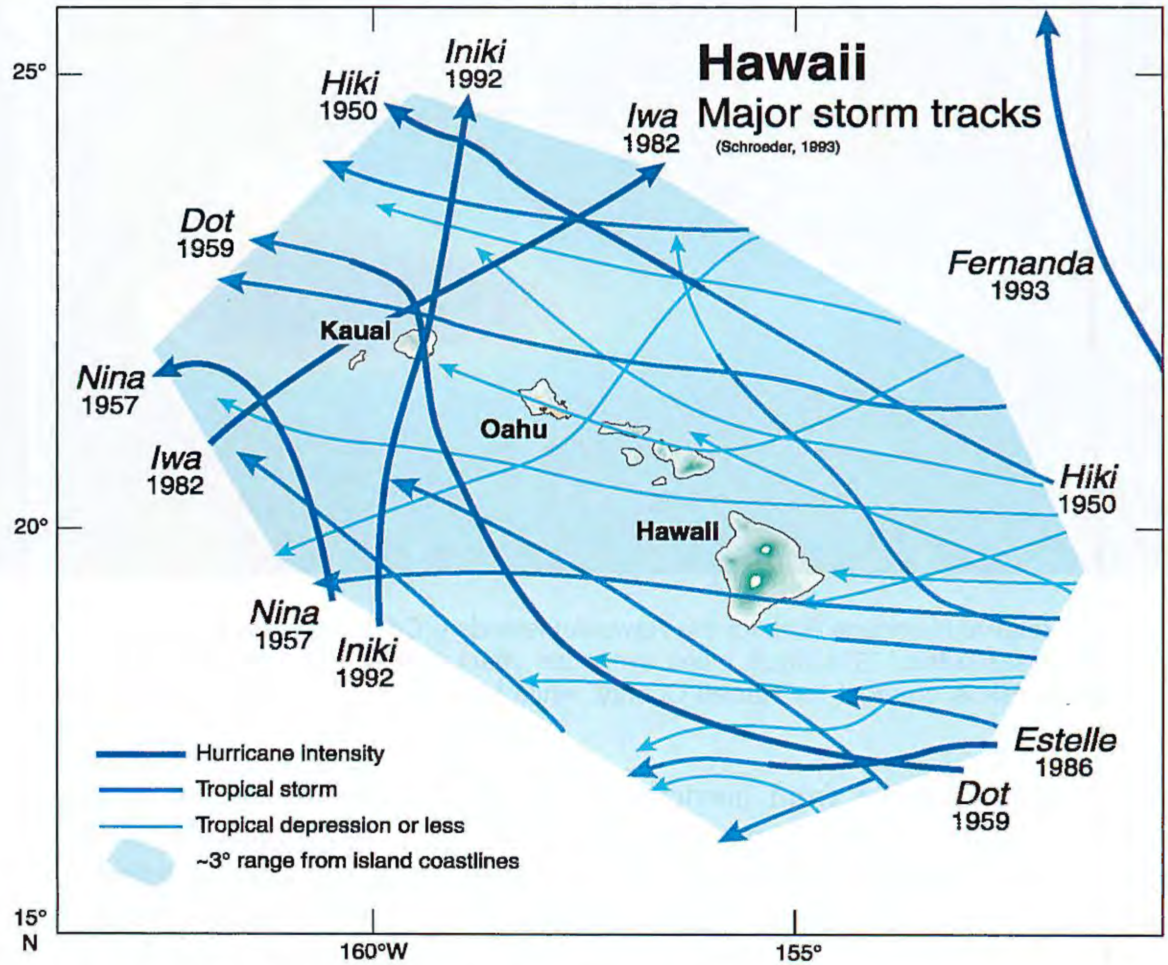


Figure 3-6 – Past Storms in Hawaii - Tracks of the major storms that have affected the Hawaiian Islands. From Fletcher et al., 2002.

Based on analysis of historical storms, and simulating hundreds of thousands of storms in the east and central Pacific, there is an indication that Hawaii County has a greater long-term hurricane hazard risk than the other islands, with the risk decreasing to the northwest along the Hawaiian chain (Figure 3-7). Thus, Maui and Oahu would have a long-term hurricane risk that is intermediate between Hawaii and Kauai. This differential hazard across the State appears consistent with the physical process of hurricane formation and migration from the east Pacific to the central Pacific (Oahu Civil Defense Agency, 2003). The significance of these findings is that all of the islands should be very vigilant in planning for and mitigating the damage associated with erosion, wave inundation, flooding, wind and rain that comes with any hurricane.

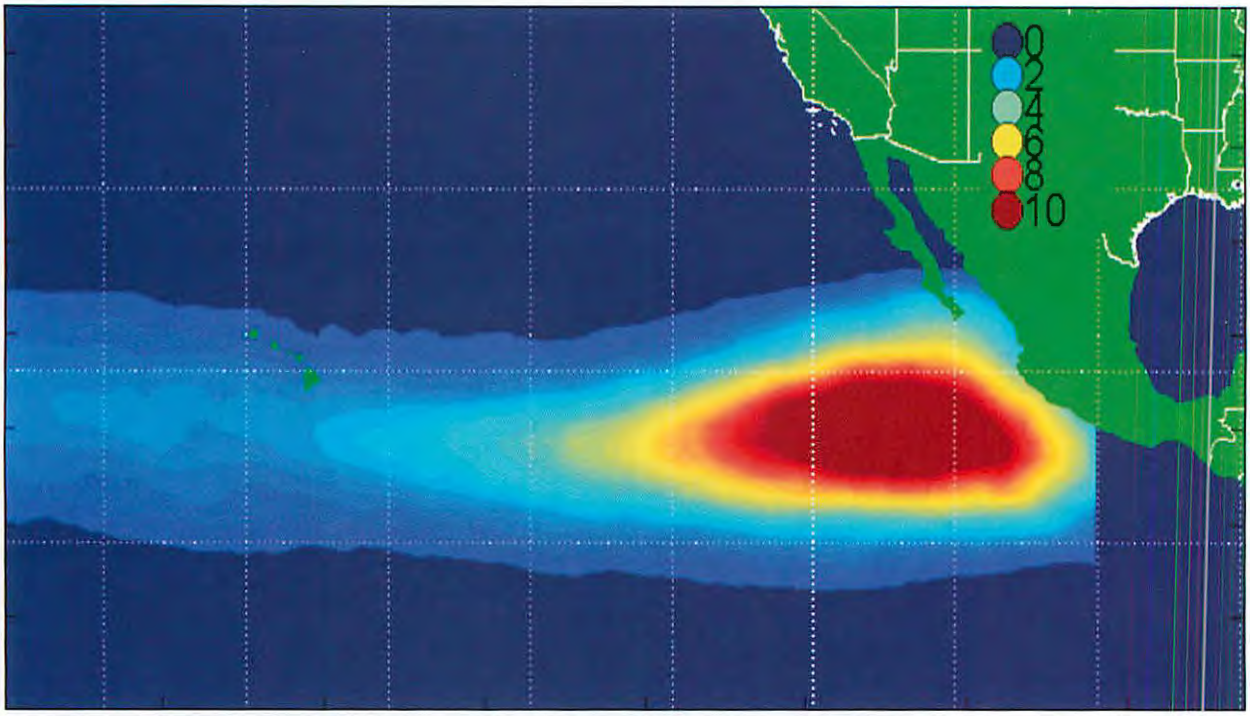


Figure 3-7 – Relative Hurricane Risk for the Hawaiian Islands - Contours show the number of times a hurricane passes within 75 nautical miles every ten years (Oahu Civil Defense Agency, 2003). Contours show risk is greatest for Hawaii County, while Maui and Oahu have slightly greater risk than Kauai.

The major damage from hurricanes is caused by storm surge, rain and wind (Hawaii Hazard Mitigation Forum: Mother Nature, 2002). With regard to storm surge and wave inundation for hurricanes, this should be treated similarly to inundation by tsunamis and coastal flooding (See Sections 3.5, 4.2 and 4.4). One distinction is that the wave action and flooding from hurricanes may be at different intensities for different sections of the coastline. Nevertheless, the base flood elevations for the islands of Hawaii are based on extreme flood events due to tsunamis and for areas that have been stricken by hurricanes. At one time hurricanes were not felt to be an important factor in flooding. After Hurricanes Iwa and Iniki, the Flood Insurance studies for Kauai were updated to account for inundation from these events. Coastal properties on Kauai suffered extensive damage from storm surge from Iniki and Iwa (Kauai General Plan – p. 3-13).

From the above, construction of structures above the base flood elevation, with freeboard added to provide a margin of safety, should provide the minimum degree of protection. A hazard assessment should determine if the storm surge can be addressed during the construction stages of development, or if the issue needs to be addressed earlier during the siting stages of development.

Generally, the damage from rain and wind can be addressed during the construction stage of development (Stage 7 – see Chapter 11). Key is the creation of a wind and rain resistant envelope (FEMA CCM p. 4-8 and Chapters 12-14). It is in the building code, that appropriate construction standards are provided to address these issues.

The City and County of Honolulu, Maui and Kauai Counties follow the 1997 Uniform Building Code ("UBC"). Hawaii County follows the 1991 UBC. The UBC has standards that address wind loads. The UBC factors in: (i) a basic minimum wind speed, (ii) exposure coefficients based on local terrain and height, (iii) pressure coefficients for the portion of the building under consideration, and (iv) an importance factor based on intended use of the structure.

The individual counties may eventually adopt the International Building Code ("IBC") instead of the UBC.[9] The reader should check with the respective county building department (Table 2-1, Row 8) to determine the relevant building code, or recent amendments that may be applicable for a specific project.

Winds are expected to be greatest for open exposed coastal areas (Figure 3-1). The building code accounts for this in the height, exposure and gust coefficient. Depending on the height of the structure, the design winds along the coast may be more than 50% higher than for an inland property surrounded by buildings, trees or other irregular surfaces.

Although winds will diminish inland, the strength of hurricane winds is also dependant on topography. Winds accelerate as they descend from the mountains to the coastal plains. In many instances, the highest recorded gusts associated with passing storms have occurred on the side of the island opposite the storm's approach as winds burst in downdrafts across ridge crests from the steep pali to the coast below (Hawaii Hazard Mitigation Forum: Mother Nature, 2002). In some areas, topography may cause winds to accelerate by 30-40%, or more.[10] The IBC is apparently more protective than the UBC with regard to the wind hazard because it considers wind directionality and topographic speedup as key parameters in the design.

Currently, there are efforts to map areas in Hawaii that have topography likely to accelerate wind speeds during a hurricane. First generation wind maps that relate gross variations of wind speed with topography have been created for the islands of Oahu, Kauai, Lanai and Molokai (Figure 3-8). In coastal areas away from topographical relief, these wind maps can be used for design. For developable areas near topographic relief, higher resolution maps are needed for design. High resolution wind maps that can be used for design are being created for the island of Oahu at the office of Martin & Chock,

[9] At the time of this writing, Oahu and Kauai were moving to adopt the 2003 International Building Code, while Hawaii County was considering adoption of the 1997 UBC.

[10] Interview with Gary Chock, structural engineer for Martin & Chock, Inc.

Inc. These maps will facilitate implementation of the standards in the IBC. Due to the potential for considerable damage from a hurricane (Table 1-1) and the equal likelihood that a hurricane can strike any island (Figure 3-7), these maps should be developed for all the islands in order to significantly reduce potential damage from a hurricane.

Since the intensity of high winds is affected by topography, the hazard assessment should indicate if special measures should be designed in the structure during any construction. An identification of a high wind area may require design of a house to withstand winds stronger than specified in the relevant building codes.

To identify suspect areas, the first point of reference, besides the relevant building code, would be current wind maps and those under preparation. If wind maps of sufficient resolution do not exist, a consultant can be retained. Due to the expense of a localized assessment, this analysis may be more appropriate for a subdivision (Stage 4) versus the building of a single structure on an infill lot (Stage 7). For the building of a single home in a suspect area, it would likely be less expensive to build to a higher standard than to commission a localized wind study.

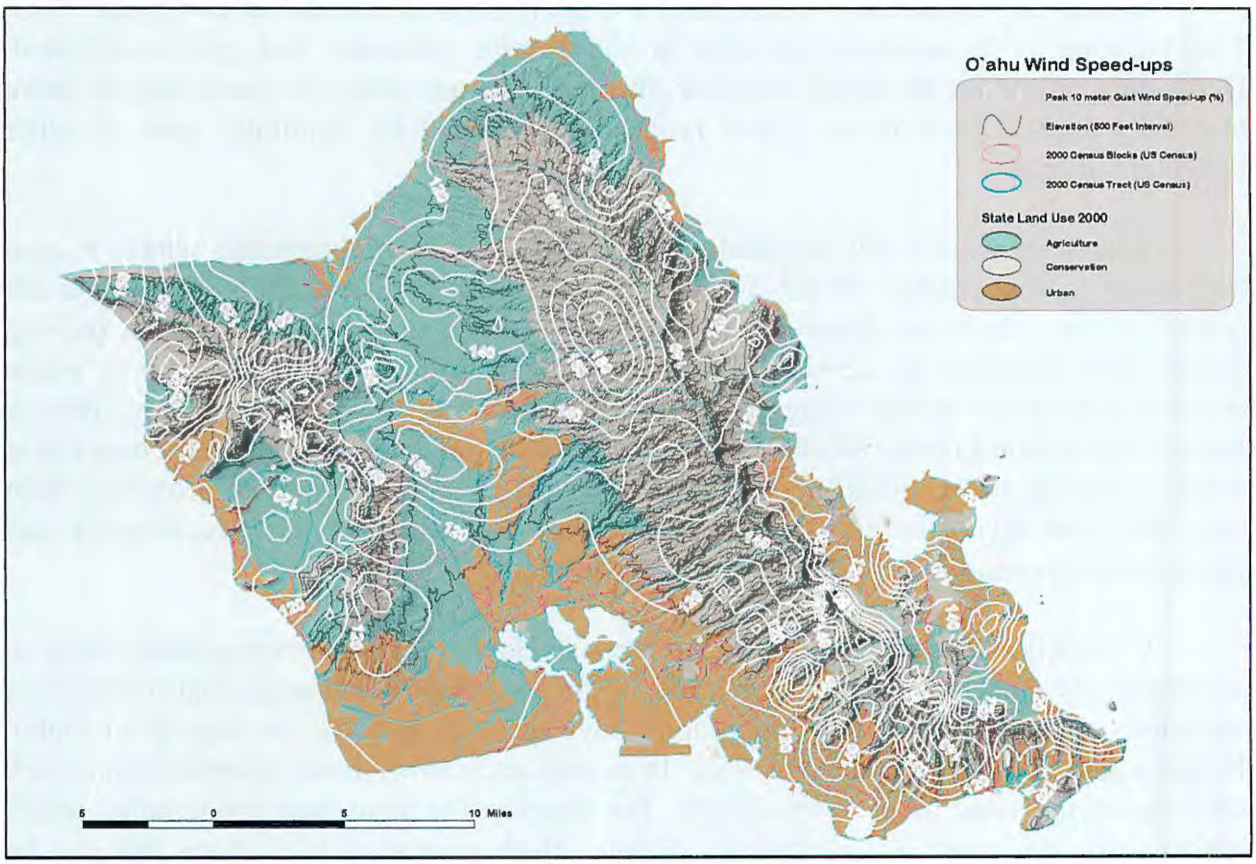


Figure 3-8 – Affect of Topography on Wind Speed, Oahu – Contours on the wind map indicate the percent increase in wind speed due to topography at an elevation of 10 meters over the ground surface. From Chock et al, 2002.

3.6 Lava

Lava may become a coastal hazard when the flow reaches the ocean. This is especially true where steep topography tends to decrease at the shoreline causing lava flows to greatly "fan-out," or spread laterally onto adjacent land. This hazard cannot be addressed with proper construction techniques and therefore, mitigation is primarily a siting issue.

The Lava Flow Hazard Mitigation Plan was prepared by the Hawaii State Civil Defense (2002) in cooperation with the Lava Flow Hazard Mitigation Plan Technical Committee. According to this study, land use planning and zoning practices provide the most comprehensive and far-reaching mitigation tool in reducing exposure of communities to lava flow hazard. To be most effective, the control of development in areas subject to lava should be addressed at Stages 1-3 of the development hierarchy (Figure 2-6).

The areas with a high risk of lava flow are limited geographically to the Islands of Maui and Hawaii. The U.S. Geological Survey has identified lava hazard zones for the island of Hawaii. Zone 1 is the greatest hazard while Zone 9 is the least risk (Figure 3-9). This zonation is based on the percent area covered by lava flows since 1800 and over the last 750 years (FEMA, 1990). The Hawaii Volcano Observatory may develop probabilistic (statistical) lava flow maps that will better estimate the probability of lava inundation and will further assist in the land use planning process.

Some important recent resources in the assessment and planning for lava risks are: 1) the Lava Flow Mitigation Plan – Reducing the Risk of Lava Flows to Life and Property, (Hawaii State Civil Defense, 2002); and 2) the Atlas of Natural Hazards in the Hawaiian Coastal Zone, (Fletcher et al., 2002). The reader should also consult with the county planning departments for measures on mitigating the risks from lava, as well as the Hawaii State Civil Defense office and the Hawaii Volcano Observatory for any new reports or refined lava flow maps.

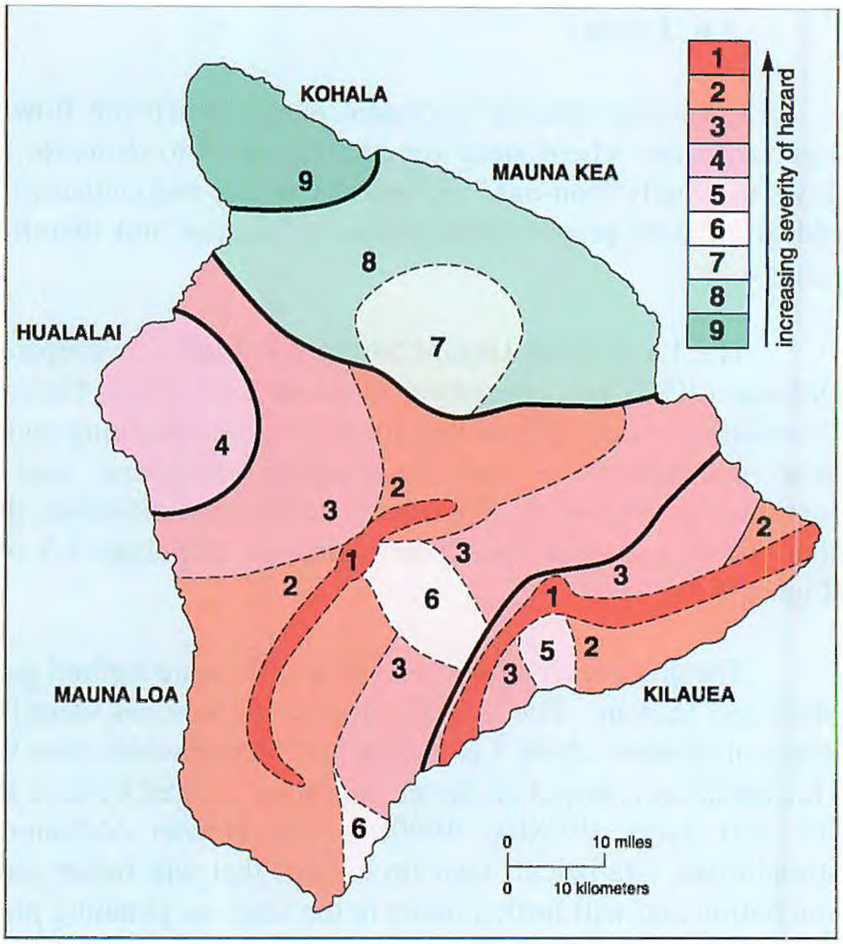


Figure 3-9 – Lava Zones - Lava flow zones have been mapped for the island of Hawaii. The most intense activity is marked in red and labeled Zone 1 (From Heliker, C., 1990 and Fletcher et al., 2002). Work is currently underway at the Hawaii Volcano Observatory to develop new maps.

3.7 Earthquakes

Areas that are subject to lava flow are also likely to be subject to earthquakes. On a broad scale, Hawaii County is most subject to seismic risks, being in Seismic Zone 4. The seismic risks for each island to the north progressively decreases, with Maui, Molokai, Lanai and Kahoolawe in zone 2B, Oahu in zone 2A, and Kauai in Zone 1 (Uniform Building Code, Chapter 16 – Division IV – Earthquake Design, Figure 16-2).

The distribution of seismic risks for the Hawaiian chain is represented graphically in Figure 3-10. This map compares for various island sectors, the peak horizontal acceleration as a percent of gravity for events which have a ten percent chance of being exceeded every 50 years.

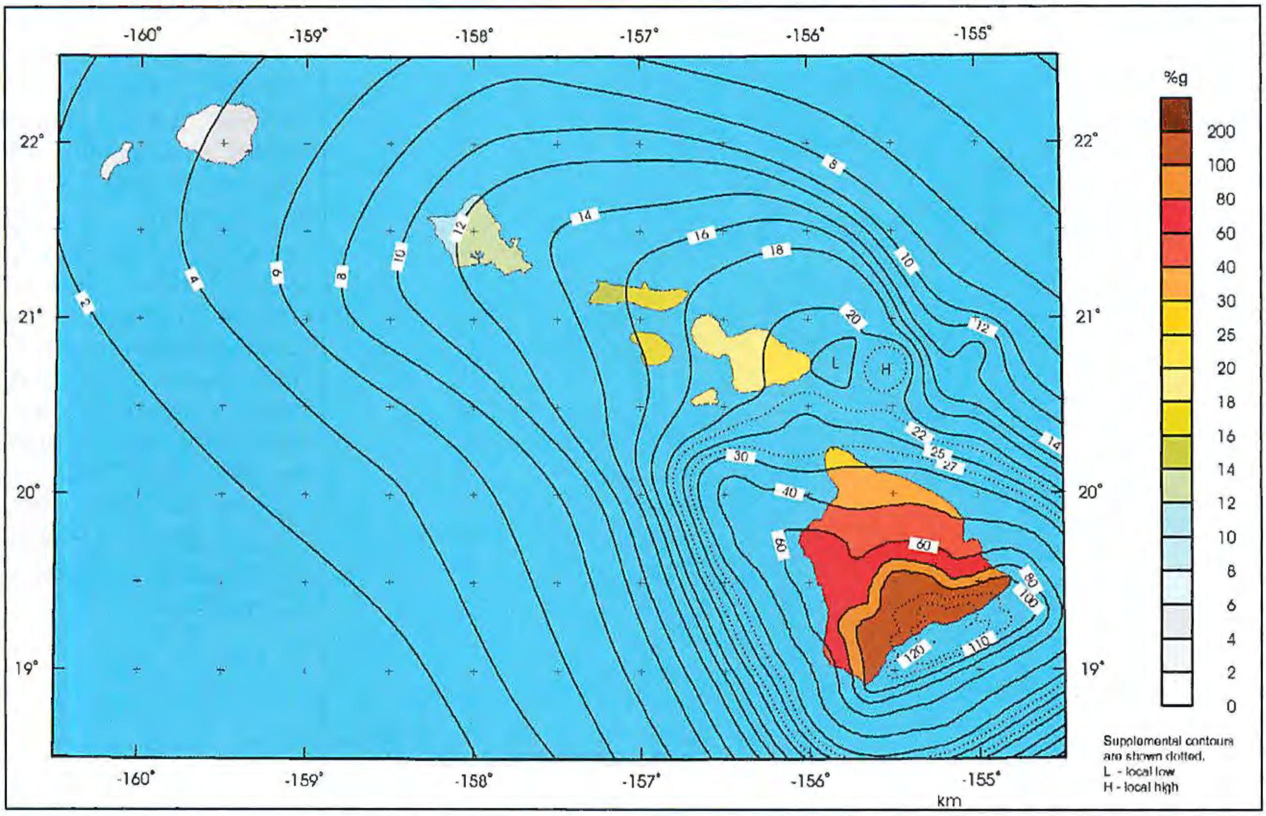


Figure 3-10 – Earthquake Risk in Hawaii - Earthquake risk, as indicated by the magnitude of peak horizontal acceleration expressed as a percent of gravity for events with a 10% probability of exceedance in 50 years is compared for the various islands. The risk is greatest for Hawaii County and diminishes progressively to the northwest. Tsunamis caused by local earthquakes are likewise concentrated in Hawaii County. From U.S. Department of the Interior, U.S. Geological Survey.

The State Civil Defense recommends that for all the islands, and in particular Hawaii County, the seismic provisions in the International Building Code ("IBC") be followed.[11] Hawaii County currently uses the 1991 UBC and is moving towards adoption of the 1997 UBC, with amendments that mimic the seismic provisions in the IBC. Developers, architects and planners can be proactive by designing in accordance with the IBC for earthquake design in Hawaii County, even though it currently may not be required.

The IBC incorporates two new near source factors, Na and Nv, into earthquake design. These factors relate shear stress to the proximity of known faults with specific magnitudes and slip rates. The United States Geological Survey and State Civil Defense have developed a more detailed seismic risks map of these near source factors. With a more refined distribution of seismic risks (Figure 3-11), building design can better match the analyzed risks, leading to greater efficiency and stronger construction where it is needed.

[11] Interview with Brian Yanagi, State of Hawaii Civil Defense

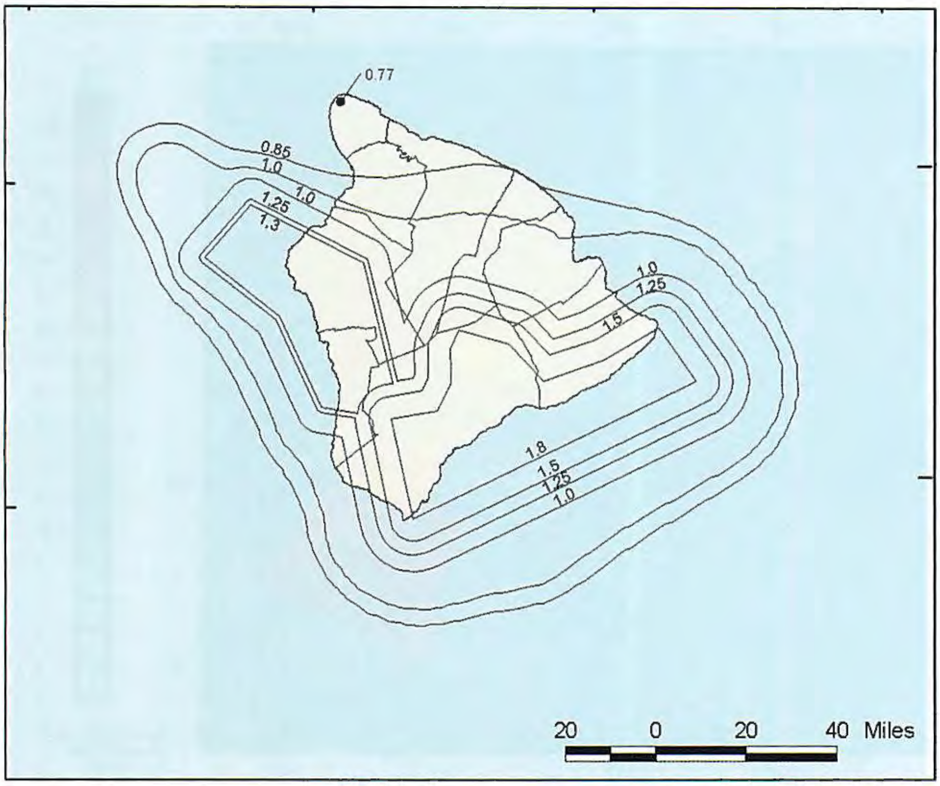


Figure 3-11 – Seismic Coefficients for Hawaii County - Example of refined near source factor distribution for Hawaii County, which is related to the proximity of an area to known faults. Seismic risk is greatest in the south central portion of the county. This map was created through state of the art analysis by the U.S.G.S with the assistance of the State Civil Defense's Hawaii Earthquake Advisory Committee.

Discussion with the State Civil Defense office indicated earthquakes are a natural hazard that can be addressed during the construction stage of development by following applicable building codes, provided that that the current International Building Code is followed.

Relevant resources for the planning and assessment of the earthquake risk include the Atlas of Natural Hazards in the Hawaiian Coastal Zone (Fletcher, et al., 2002), current editions of the Uniform Building Code & International Building Code, and relevant reports from the Hawaii Earthquake Advisory Committee which was established by Hawaii State Civil Defense.

While earthquake risks can generally be dealt with during the construction stage, this may not be the case if the earthquake is associated with lava flows or there is subsidence of the land. Furthermore, development near seismic activity can become a siting issue if there is development directly on an active fault. Hawaii County is most susceptible to this risk. Another potential siting problem is seismic activity along unstable slopes. The hazard assessment should be able to determine if these issues would require special siting considerations.

3.8 Subsidence

With regard to subsidence, the southeast sections of Hawaii County are particularly susceptible to this hazard, which may be caused by movement of underground magma and/or slippage along faults. Subsidence along the coast can lead to the exposure of residences to flood waters or wave action. This exposure may require that structures be built above flood waters (Figure 3-12).

Figure 3-12 – Kapoho Vacationland Subdivision, Hawaii - Subsidence of land at the Kapoho Vacationland Subdivision has resulted in homes being exposed to flood waters and wave action during monthly high water levels. Homes have been elevated to mitigate flood damage.

While the impacts of subsidence can be mitigated by the elevation of structures, subsidence is viewed as a siting issue in this report because it may be extremely difficult to deal with the problem at the construction stage. First, the amount of subsidence is difficult to predict. During the Kalapana earthquake of 1975, the subsidence varied along the coast, from 11.5 feet near Keahou Landing to 0.8 ft. at Kapoho (from USGS – Hawaii Volcano Observatory, 1995). The second problem is that localized subsidence along the coast is still ongoing. It has been estimated that Kapoho continues to subside at a rate of approximately a few centimeters per year as the lower east rift zone near Kapoho widens (Proposed Amendments to the Hawaii County General Plan).

Like many other coastal hazards, the large extent of the subsidence area coupled with pre-existing development pressure – (i.e., not addressing the issue early in the development process) may make avoidance of these areas difficult.

3.9 Summary of Coastal Hazards and the Stage of Development to Address the Hazard

Coastal hazards and the suggested stages to implement mitigation measures are summarized in Table 3-1. Note that avoidance is recommended for coastal erosion, bluff erosion and lava. Lava is included because this hazard cannot be mitigated by proper construction. Avoidance of coastal erosion and bluff erosion is compatible with Figure 3-1, in which the most seaward zone, the erosion zone, is subject to the most intense and varied natural forces. Avoidance of development in the erosion zone will reduce, but not eliminate the risks from flooding and inundation from tsunamis and hurricanes.

Avoidance of development in the erosion zone is also consistent with the FEMA CCM, since that manual attempts to mitigate the impact from all natural hazards, but recommends a coastal setback based on the extent of an erosion zone, which is determined by the erosion rate and the life expectancy of proposed structures. Since mitigation of these hazards is so dependent on siting, these issues should be addressed during the earliest siting stage of development (Figure 2-6).

As further shown in Table 3-1, the wave or V zone inundation is treated similarly with hurricane and tsunami inundation, as well as subsidence. Since these hazards may affect an area thousands of feet inland, complete avoidance may not be possible, and therefore, construction measures are also needed to assist in mitigation. It is logical that the wave or V zone, tsunami and hurricane inundation are treated similarly, since the flood insurance studies for Hawaii compute the inland extent of V zones based on inundation from tsunamis and hurricanes that occurred in the area. Even though numerous hazard mitigation reports recognize that difficulty of avoiding development in such a large area, nevertheless, a hazard assessment should evaluate unusual risks for a particular locality which may warrant special siting considerations (Chapter 4).

There are hazards in Table 3-1 that can, in general, be dealt with during the construction stage of development. These include flooding in the A, AE, X zone (see Flood zone – in Figure 3-1), earthquakes, wind, and rain. Generally, development can occur in these areas with proper building techniques. The exception is that for critical facilities, the wave (V-VE) and flood (A-AE-X) zones should be avoided, or an attempt should be made to avoid this area unless proper infrastructure is provided for access.

Given the importance of site specific conditions, a hazard assessment can determine whether the generalities in Table 3-1 are still applicable. For example, earthquake mitigation is primarily a construction issue. Despite the seismic zonation in Figures 3-10 and 3-11, the hazard assessment may determine that a proposed project is too close to an active fault, or near an unstable slope and that greater siting concerns should be addressed.

Table 3-1 – Summary of Hazards, Siting & Building Issues, Location Characteristics and Recommended Stages of Development to Address

Hazard	Siting Issues	Building Issues	Location	Stage of Development to Address Hazard*
Coastal Erosion	Yes – Avoid – Establish erosion zone	Location of structure on lot	Sandy coastlines	1 through 8
Bluff Erosion	Yes – Avoid – Calculate bluff erosion to determine erosion zone	Location of structure on lot	Readily identifiable by site visit	1 through 8
Coastal Flooding	Wave Zones (V, VE zones) - Attempt to Avoid, for critical facilities – Avoid; Flood Zones (A, AE, Z zones) – for critical facilities – Avoid	Elevate lowest horizontal structural member above BFE; consider freeboard to add margin of safety; location of structure on lot	Along coastal areas, adjacent to streams; may also be away from the coast – check Atlas of Natural Hazards in Hawaii & FIRMs	1 through 8
Tsunamis	Attempt to Avoid, for critical facilities – Avoid	Elevate, locate on higher part of lot, slow water, steer water, block water; location of structure on lot	All coastal areas – check Atlas of Natural Hazards in Hawaii & FIRMs	1through 8
Hurricane Storm Surge	Attempt to Avoid, for critical facilities – Avoid	Elevate, locate on highest part of lot; location of structure on lot	South shores of islands at higher risk.	1 through 8
Hurricane Wind	No	Follow applicable building codes – assess if higher standards needed for particular site based on topography. Create wind and rain resistant envelope.	Coastal areas have higher winds due to open exposure. Inland areas may be affected by topography – check ongoing mapping studies (see Section 3.5).	7, 8 Probably no disclosure requirement for hurricane wind.
Hurricane Rain	No	Follow building codes – create wind and rain resistant envelope	All coastal and inland areas	7, 8 Probably no disclosure requirement for hurricane rain.
Earthquakes	No – unless building directly on fault – Avoid unstable slopes	Follow applicable building codes; Hawaii County - follow current IBC, or equivalent for seismic design	Major risk in south central portions of Hawaii County – check Atlas of Natural Hazards in Hawaii	7, 8
Lava	Yes – Avoid	It is not possible to build correctly to mitigate the impact from lava.	Southeast, southwest and central portions of Hawaii County at greatest risk – check Atlas of Natural Hazards in Hawaii	1 through 4 – only for Hawaii and Maui County
Subsidence	Yes – Attempt to Avoid – may coincide with areas of high earthquake risk	If avoidance not possible, elevate with sufficient margin, while providing for adequate design of earthquake forces	Southeast coastal areas of Hawaii County	1 through 8

* Once hazards are properly addressed in a specific development stage, they do not need to be addressed in subsequent development stages. See also Footnote 7.

Chapter 4 – Determining the Erosion, Wave (V-VE), Flood (A-AE-X) & Inland Zone in the Hazard Assessment

The erosion zone in Figure 3-1, is a key zone in coastal hazard mitigation because it is: (i) subject to the most intense natural forces; (ii) the area exposed to the greatest diversity of forces; and (iii) spatially small enough so that with reasonable siting and construction practices, coupled with early planning and innovative design, avoidance is possible.

According to the FEMA manual, the erosion zone should be based on:

1) Using a published or calculated long-term erosion rate (ft/yr), increase the rate to account for errors and uncertainty. It is recommended that a minimum of 1.0 ft/yr be used unless durable shore protection or soil-resistant to erosion is present.

2) Multiply the resulting erosion rate by the building or development lifetime (years) to compute the long-term erosion distance (ft). Use a minimum of 50 years.

3) Measure landward (from the most landward historical shoreline) a distance equal to the long-term erosion distance – this will define the most landward expected shoreline.

The formula proposed in the FEMA CCM is well suited for shoreline processes along the east and gulf coast of the United States. In these areas, long stretches of the coastline face similar wave regimes and have experienced long term erosion that is fairly consistent and predictable, when averaged over multi-yearly periods.

Some authors have noted that for the Pacific Northwest (Oregon and Washington), the long-term trend erosion is not as important as storm erosion, in which storm events cause severe episodic erosion of the dune, and then the beach recovers over the seasons or a multi-yearly period (Komar, et al., 2002). A setback formula has been proposed based on a geometric model to estimate the maximum horizontal extent of dune erosion during a storm plus the long term erosion trend risk (Komar, et al., 1999).

Other authors include in the setback determination the long term erosion rate, dune cut and fill, sea level rise, a dune topographic stability factor, storm surge, and tsunami inundation (Healy, et al., 2002; Healy and Dean, 2000). Due to the large inland extent of the storm surge and tsunami inundation zone, such a strategy may not be feasible in Hawaii. Nevertheless, concepts in the Healy papers could be applied in this manual if the agencies decide to treat the wave (V-VE) or portions of the flood (A-AE-X) zone as a setback, instead of as a zone with specific construction requirements.

The beaches of Hawaii have a diverse pattern of shoreline change that is partly due to having exposure to different wave types depending on the location of the beach along the island's coast. The four major wave types in Hawaii are: (i) Northeast Trade Waves, (ii) North Pacific Swell, (iii) Southern Swell, and (iv) Kona Storm Waves (Figure 4-1).

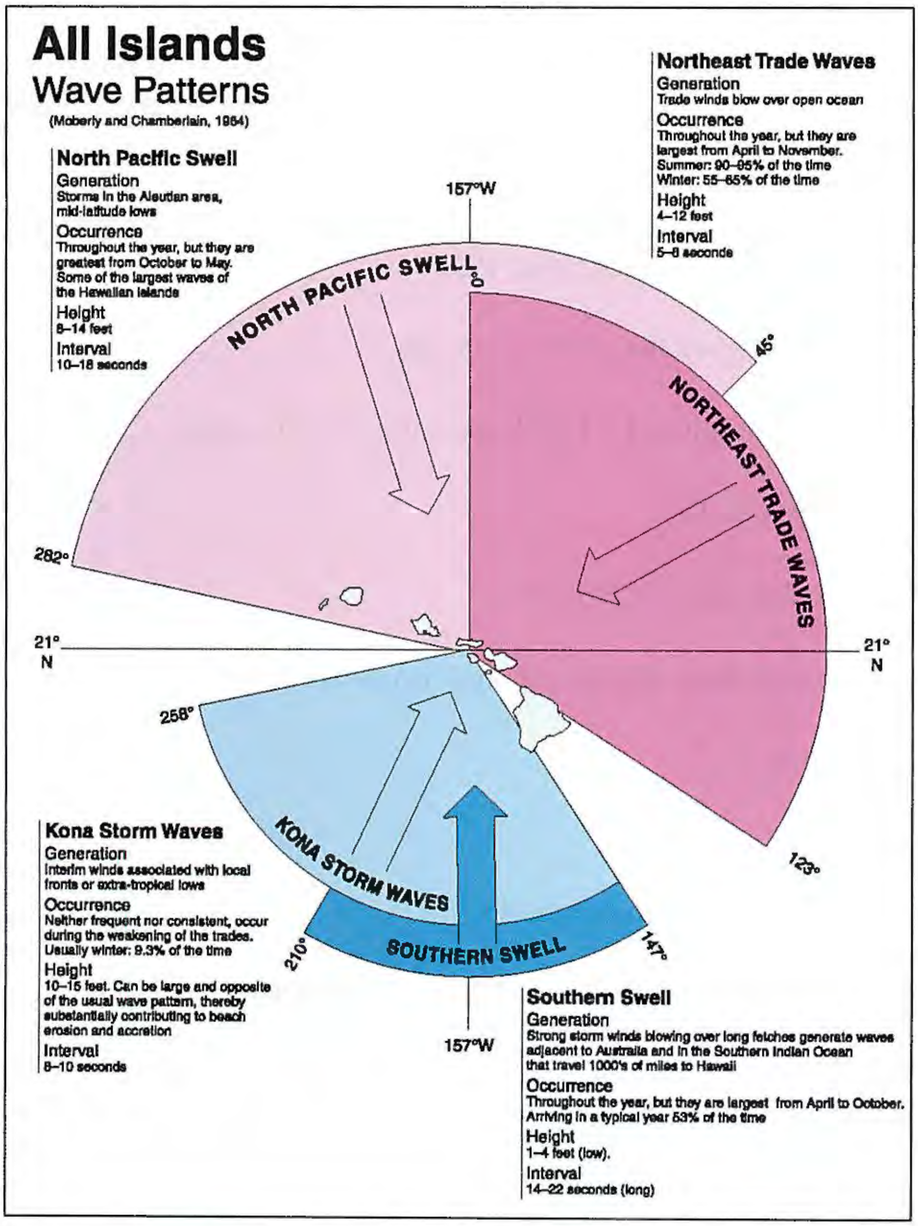


Figure 4-1 – Major Wave Types in Hawaii - Northeast Trade Waves are caused by Northeast Trade Winds which blow year round but are most persistent in the summer. North Pacific Swell are generated by large storms in the North Pacific during the winter and may travel thousands of miles to reach the islands. Southern Swell are caused by large storms in the South Pacific during Hawaii's summer. Kona Storm Waves are caused by localized tropical storms that are present in the winter. Different orientations of the beach result in significantly varying wave regimes. As a result, some beaches may have change dominated by a linear trend, while others may be more influenced by storm events. From Fletcher et al., 2002.

Due to the diverse nature of the Hawaii shoreline, a setback formula is recommended that combines features in FEMA's CCM, which are especially applicable for East and Gulf Coast States, and the setback formula in recent studies for the Pacific Northwest States, where storm erosion events are of major concern (Komar, et al., 1999).

4.1 Recommended Erosion Zone Formula

The erosion zone in this manual is determined by the formula below and consists of three major factors: the trend risk, the storm erosion event, and a design safety buffer.

Erosion Zone = Trend Risk + Storm Erosion Event + Design Safety Buffer

The **Trend Risk** is determined by multiplying the planning lifetime of buildings (70 to 100 years) times the erosion rate. The erosion rate is adjusted for errors (FEMA CCM, 2000) and sea level rise (Komar et al., 1999).

Trend Risk = (Life Expectancy of Structures) * (Erosion Rate * Adjustment for Errors * Adjustment for Accelerated Sea Level Rise)

Thus, the parameters needed to determine the erosion zone are:

- Planning Period – Determined by Life Expectancy of Structures
- Average Annual Erosion Rate
- Adjustment of Erosion Rate for Errors
- Adjustment of Erosion Rate for Accelerated Sea-Level Rise
- Storm Erosion Event
- Design Safety Buffer

A discussion of the relevant parameters follows.

4.1.1 Planning Period - Life Expectancy of Structures

The FEMA CCM recommends that for the building lifetime, a minimum of 50 years be utilized. Consistent with the FEMA recommendation, but more specific, it is recommended that a 70-year lifetime be utilized for residential structures during the subdivision stage of development.

The 70-year time frame is based on a study conducted for the Federal Insurance Administration, Department of Housing and Urban Development to establish reliable estimates for the life of coastal residential structures (Anderson, 1978). Ten regions in the U.S. were studied for life estimates based on the time in years from the initial construction to the termination of use as a habitable structure. The estimate was based on maintenance, economic use of appreciating land, structural failure, water damage, habitability, and outmoded style or utility, among other factors. For a single family wood residence without block or bricks, the base life in years ranged from 50 to 100 years, with the average for the ten regions in the United States at 70 years.

The 70-year time period is recognized in several reports as a suitable period to calculate an erosion zone, since it is the average life of a building (Heinz, 2000). According to coastal geologist and engineer Spencer Rogers, "a low standard such as a 30-year setback may delay, but does not eliminate, the long-term erosion problem (Sea Grant Media Center, 1999).

In a study to determine a suitable erosion setback, the 70-year time frame was recommended in order to balance erosion risks with the risks of flooding along the coasts (Rogers and Jones, 2002). According to the study, over a 70-year period, the chance of a flood exceeding the 100 year flood level is 51%. The 100-year flood level is set by the National Flood Insurance Program and FEMA. If the 100-year flood level is exceeded, there is likely to be serious flooding or damage, unless there is a built in safety factor. Also from the study, the risk that a structure will be undermined from erosion is 50%, when a structure with a 70-year life time is constructed with a 70 year setback. Thus, for a structure with a lifetime of 70 years, the 70 year erosion setback is best for balancing erosion and flooding risks, with the risks being 50% and 51%, respectively.

The justification for balancing risks of hazards in building design is that it would be inefficient to design a building with significantly different risks levels.[12] For example, if a house with a 70 year lifetime is built with a 30 year erosion setback, the risk that it would be undermined over its life would be 100%, for shorelines with low variability in erosion rates (Rogers and Jones, 2002). With regard to flooding, the risks of exceeding the 100 year flood would be 51% during that 70-year period. Measures implemented to mitigate flood damage could be viewed as a waste of resources when it is highly probable that the house would be threatened considerably beforehand by erosion.

The 70-year lifetime for structures should not be viewed as conservative, since it is based on an average of structures nationwide (Rogers and Jones, 2002). For a new subdivision along the coast with 100 lots, it would be expected that 50 of the structures built will last longer than 70 years, while the other half would last 70 years or less. With a 70-year shoreline setback, half of the structures would be threatened before the end of their useful life. With a 50-year shoreline setback, the majority of the houses would be undermined before the end of their useful life.

One of the key factors, as considered in the 1978 HUD study, is maintenance. Discussion with a local architect indicates that if a new house is properly maintained,

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[12] Interview with Spencer Rogers, North Carolina Sea Grant

with painting every ten years, termite treatment and inspection every five years, and reroofing every thirty years, it should last indefinitely.[13]

Another key factor in life term is building materials: the introduction of stone or brick is likely to significantly increase life expectancy. For instance, the utilization of brick in a single family homes raised the base life term for the ten regions of the United States to an average of 104 years (Anderson, 1978). The larger the structure, the more likely that it will be made with stone or brick. For this reason, many states have proposed varying setbacks for structures of different size (e.g., North Carolina and Oregon have proposed different setbacks for large structures).

It is suggested that for very large structures, resorts, condominiums, or for development decisions in which the type of structures are not ascertained and the land is still zoned for low density use, a 100 year setback be implemented. This time frame is similar to the 100 year-flood period that determines FEMA's Special Flood Hazard Area, the area subject to inundation by a flood that has a 1 percent probability of being equaled or exceeded in any given year. A coastal hazard zone based on a 100-year setback has been applied in New Zealand (Healy, 2002).

The agencies may wish to make their own analysis on the life expectancy of coastal structures. Such an analysis should consider building materials, maintenance, water damage, habitability, and other factors determined by the agency. Given the information currently available, however, 70 years is the best estimate for the life of small wood frame residences. In addition, the 70 year time frame appears to generate the proper setback given a scenario with an erosion rate of .5 ft/yr (see Section 4.1.8).

In summary, a 70-year setback is preferred for new residential subdivisions in which the structures are less than a minimum size determined by the counties. A 100-year setback is suggested for areas that are to be rezoned or reclassified for higher density use in which the exact use is undetermined, or for large nonresidential structures such as hotels and condominiums. The implementation of the 70 or 100-year setback at the State reclassification stage or county rezoning stage should be easier to implement because of the factors outlined in Figure 2-5. Counties may consider utilizing the larger setback for new subdivisions in which very large residential structures would be built along the coast, e.g., structures with a footprint greater than 2,500 square feet.

4.1.2 Erosion Rate

The FEMA CCM recommends the use of published or calculated erosion rates to help determine the erosion zone. Erosion rates can be obtained from erosion studies that have been conducted in the past (Appendix A) or, if the data is not available, it is

[13] Interview with Peter Aiello, Architect for D.R. Horton - Schuler Homes LLC

recommended that a qualified professional consultant be hired to calculate the rate. Key zoning and subdivision decisions that are made with no or outdated planning data will likely result in poor siting decisions.

Generally it is recommended that if the erosion analysis is older than five years, a new study or an updated study be conducted for a specific project site. This is consistent with the schedule of updates for FEMA's FIRM maps. As of 1994, every community in the NFIP was to have the flood maps reviewed once every 5 years to determine the need for revisions (Heinz Study, 2000). While this five year period for revision review is ideal, it has proven a difficult target for FEMA to meet.

With regard to existing data, the most recent study is the analysis conducted by the School of Ocean and Earth Science Technology at the University of Hawaii for Maui County (Fletcher, et al. 2002). An example of the analysis is provided in Figure 4.2. In the UH study, historical aerial photographs and NOAA T sheets were examined to determine how the beach has changed over time. Erosion rates were then calculated that can be used to determine the erosion hazard zone. These maps can be found at the website: http://www.soest.hawaii.edu/coasts/erosion.html.

Figure 4-2 – Erosion Map of Kihei, Maui – The yellow lines perpendicular to the coast are transects from which shoreline change data are measured. The violet line along the coast is from a NOAA T sheet. The other colored lines represent positions of the beach toe on aerial photographs of different years. As the beach changes through time, erosion rates can be determined. The red line is a projection of the erosion rate times a planning period of 30 years. From the Study of Maui County, Fletcher, et al., 2002.

For project applications in areas where a current erosion study is not available, a determination of the erosion zone as depicted in Figure 3-1 would require the applicant to hire a qualified professional consultant to determine an erosion zone for proper siting (Appendix B).

For the erosion study conducted by the consultant, a standard of analysis is recommended so that erosion rates may be calculated with a reasonable degree of uniformity, consistency and freedom from undue bias or subjectivity.

The goal of historical erosion studies is to identify the long-term trend of shoreline change to come up with an erosion rate. Uncertainties around this trend include seasonal patterns of shoreline change, tidal shifts, storm and high wave influences and other short-term impacts. These uncertainties must be accurately and precisely defined in erosion studies in order to determine the long-term trend.

A distinction is made between an Erosion Reference Feature ("ERF") and a Shoreline Change Reference Feature ("SCRF") following the terminology in FEMA's report on Coastal Erosion Hazards Study: Phase One Mapping (Crowell, et al., 1999). The ERF is the reference feature on the beach from which regulatory setbacks are measured. In Hawaii, the ERF is the "shoreline," defined in Hawaii Revised Statutes ("HRS") Chapter 205A as "the upper reach of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetative growth, or the upper limit of debris left by the wash of waves." For most shoreline certifications in Hawaii, the shoreline is interpreted to be the vegetation line.

Erosion rates are typically determined by analyzing how a SCRF has changed over time through the use of historical aerial photographs. In Hawaii, SCRF's utilized in the past include the vegetation line or dune line (Hwang, 1981; Sea Engineering, 1988; and Makai Ocean Engineering, Inc. and Sea Engineering, Inc., 1991) and the beach toe (Coyne, et al., 1999, Fletcher et al., 2002). The beach toe is identified as the change in slope at the transition between the nearshore and foreshore regions of the beach (Coyne, et al., 1999).

There are advantages and disadvantages to each SCRF (see discussion in Coyne, et al., 1999; and Crowell, et al., 1999). A disadvantage of the vegetation line is that it can be artificially altered for coastlines that are heavily populated. The advantage of the vegetation line is that for undeveloped coastlines, this SCRF is unlikely to be altered and thus, a good indicator for future changes of the vegetation line, which is generally the ERF for the State. The vegetation line is also useful in recording storm erosion, since it may take many years for the vegetation line or dune line to recover from major storms, whereas the water line or "beach toe" is likely to recover within a few days, months or seasons.

It should be noted that the vegetation line can grow seaward at a rate faster than the natural shoreline is accreting. For example, native plants such as Aki Aki grass or beach morning glory may grow seaward rapidly and introduce a long-term source of uncertainty to the shoreline trend that is difficult to quantify (Norcross, et al., 2002). Nevertheless, this sparse vegetation can generally be identified on aerial photographs and in the field and compensated for. For example, the vegetation line can be established where there is at least 75% or greater coverage of the backshore area. Although certain types of native vegetation can grow seaward rapidly, if the shoreline begins to erode, the native vegetation will be cut back, reflecting shoreline retreat in the form of an erosional scarp.

The beach toe or water line is a useful measurement that is largely free from human impacts on a healthy beach. This SCRF is especially useful for developed shorelines where there is a risk of human alteration and in instances where the use of the water line can increase the historical period of analysis. Furthermore, since the beach toe or water line recovers from short-term storm events rapidly, measurements over a sufficiently long-time period would help identify the long-term trend important for erosion rate analysis. One disadvantage of using the beach toe or water line is that it may be subject to large seasonal changes for beaches that have large seasonal change in wave energy. For example, the water line at Lumahai Beach on Kauai fluctuated on the order of 350 feet over a season (Moberly et al., 1964). At Sunset Beach, the measured ranges in the position of the water line were measured at almost 200 feet, which was felt to be primarily seasonal in nature (Hwang, 1981). However, the variability introduced by seasonal changes can be corrected with beach profile data or other statistical methods.

It is recommended that the analysis of historical shoreline erosion rates be based on both the vegetation line and water line or beach toe. The vegetation line would be useful for undeveloped shorelines, to determine impacts from storm events and in instances where the wave action obscures the beach toe. The beach toe or water line is useful for developed shorelines and coupled with the vegetation line measurement, can provide information on beach width. Analyzed together, the vegetation line and water line can provide valuable information on beach width, storm events, as well as short-term and long-term beach changes.

Especially useful are plots of the position of the vegetation line and beach toe or water line against time. These plots allow comparison of the erosion rate for individual observation periods, as well as a comparison with the total period of observation (Figure 4-3). Furthermore, the plots may help to correlate significant changes in the erosion rate or cycles of erosion and accretion with storm erosion events or artificially induced changes to the shoreline.

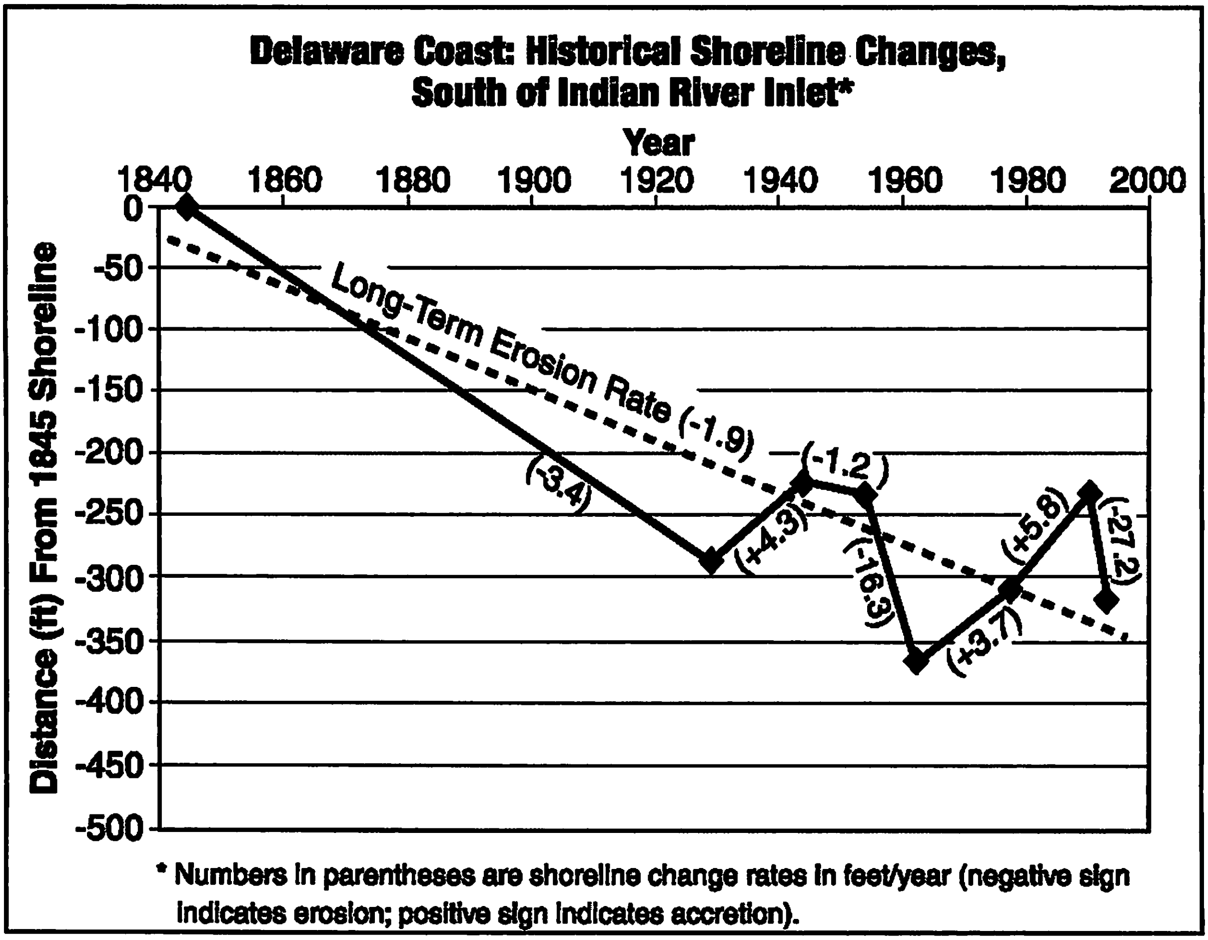

Figure 4-3 – Plot of Shoreline Position Over Time - By comparing the erosion rate for each observation period with the total observation period, erosion and accretion trends, events or cycles may be identified. These plots should be made for both the vegetation line and the beach toe or water line. From FEMA CCM, 2000.

Several articles have been written on the methodology for analyzing historical shoreline erosion rates with the use of aerial photographs (Fletcher et. al., 2003; Honeycutt, et al., 2002; Crowell, et al., 1999). Based on these studies, recommendations for the analysis of aerial photographs to determine erosion rates are provided that can serve as a standard for coastlines that have not been mapped, or where the data is outdated. In this report, it is recommended that if there is no existing shoreline erosion data, a qualified professional consultant be retained early on to determine the erosion zone, utilizing the standards in Figure 4-4 so that key siting decisions are not made without information vital for planning.

4.1.3 Errors in Calculation

There are at least two major sources of error for the erosion rates as determined from aerial photographs. First, there is an error inherent in the methodology of measuring shoreline change itself. This may be related to difficulty in interpreting the location of SCRFs, relief displacement, uncorrected tilt in the photos, measurement errors, lens distortion, and film or paper shrinkage. The FEMA CCM recommends that due to errors in the methodology, the rate of erosion be increased to account for this error. In this manual, it is suggested that a multiplier of 1.2 be utilized or the rate increased by 20% to account for errors inherent in the methodology.

The second factor is recognized by FEMA as related to uncertainty. Uncertainty may come into play if the past historical shoreline changes are not representative of future changes. While geologists generally recognize that the past record of how a shoreline changed is the best indicator of future change, there is nevertheless uncertainty in predicting future changes from past changes. There is always the possibility that future erosion events will be more frequent or intense. It is also possible that future events will be less frequent and less severe then the past. For this reason, no adjustment is given to the uncertainty factor, except for the uncertainty related to sea-level rise, which is discussed in the next section.

Although not utilized in this report, another common way to adjust for errors is to bracket the measured annual average erosion rate by one standard deviation. Thus if the erosion rate is 1 foot per year and the standard deviation is 0.2 ft/yr, the erosion rate may be cited as 1.0 +/- 0.2 ft/yr.

4.1.4 Sea-Level Rise

The sea-level change measured from tide gauges for different islands in Hawaii results from a combination of global sea-level rise and vertical movements of the individual islands. Hawaii County has the greatest rate of relative sea-level rise at 0.15 in/yr. This rate is related to loading of young volcanic rocks that are loading and sinking the lithosphere in addition to the sea-level rise. Maui has experienced sea-level rise of about 0.10 in/yr, while Oahu and Kauai have experienced a rate of about 0.06 in/yr (Fletcher et al., 2002).

Over the past 100 years, global sea-level rise has been on the order of 20 cm. (0.08 in/yr) (Healy, et al., 2002). Note that while global sea-level rise was 0.08 in/yr, Oahu experienced a relative rise of 0.06 in/yr, indicating that Oahu's lithosphere may actually be rising 0.02 in/yr. This phenomenon may be due to Oahu's lithosphere arching up in response to the bending down from the loading from the Big Island. However, recent unpublished studies indicate some, if not all of the differential sea-level rise for the various islands may be due to oceanographic factors and not geological factors such as loading on the lithosphere.

Standard to Determine the Erosion Rate

- At minimum, aerial photographs should be selected for the period from the late 1940's-early 1950's to the present. Periods of coverage should be every five years, but may vary depending on availability of coverage. See Appendix C for Sources of Photographs.

- The photographs should be corrected for tilt and distortion using ground reference points or orthophoto coverage. The correction should be in three dimensions so that all photos used are orthophotos.

- The vegetation line and beach toe or water line can be continuously digitized. An average rate of shoreline change can be determined for specific reaches. Transects can be established at the center of the lot and taken, at a minimum, every 50-100 feet in both directions. Erosion rates should be averaged in the alongshore direction to reduce variability.

- An erosion rate should be calculated for the vegetation line and the beach toe or water line. The consultant should discuss differences between the rates or erosion and the influence of manmade or seasonal changes. Discussion should be based on field observations over a period of a year. The greater of the erosion rates should be utilized.

- In identifying the position of the vegetation line in the field or on photographs, the consultant should reject: (i) artificial alterations such as human induced plantings or watering, or (ii) sparse vegetation (e.g., beach morning glory sending streamers to the water). A consistent threshold, such as 75% or greater coverage of vegetation should be utilized to identify the vegetation line on the aerial photographs and in the field. An analysis should determine if vegetation line change is less than the rate of beach width change or beach toe change.

- Linear regression should be the method used to calculate the erosion rate. Storm shorelines or statistical outlier points should be treated in accordance with linear regression methodology. Temporal bias should be avoided (e.g., selecting many photographs over a short time period to influence the linear regression erosion rate).

- The report should contain photographs of the beach and back shore, taken at different seasons of the year, and examples of the earliest and most recent aerial photograph with the locations of the selected shoreline change reference feature (vegetation line and beach toe or water line).

- The consultant should plot the position of the vegetation line and beach toe or water line versus time for all observation periods. Erosion and accretion rates for each observation period should be provided and discussed (Figure 4-3). Alternating multi-yearly periods of accretion and erosion that may result in a low erosion rate and wrongly indicate shoreline stability should be compensated for (e.g., use the most landward position of the vegetation line as a base to measure the erosion zone).

- Calculate a standard deviation, or use some other method to assess the variability of the erosion rate (See Jones et al., 2002).

- Certify that the erosion study was conducted by an experienced qualified professional using best professional judgment. A statement should be made that risks to future residents from coastal erosion, wave inundation and flooding have been minimized. Sufficient information should be included on erosion and flooding that will allow the approving county agency to certify that the site is suitable for its intended use, for structures with inhabitants that may be on site for 70 to 100 years (Chapter 8).

Figure 4-4 – Erosion Rate Standard - Where there is no suitable data, a qualified, professional consultant can be retained to determine the erosion rate utilizing the above guidelines.

According to the Intergovernmental Panel on Climate Control, the most recent estimate for sea-level rise in the next 100 years is about 49 cm (0.19 in/yr)(Healy, 2002). If sea-level rise were to accelerate as predicted, relative sea-level rise for all islands would accelerate. Since the early 1990's, satellite measurements have documented global sea-level rise at approximately .12 in/yr, which is an increase in the rate compared to measurements taken over the last century.[14] This could affect rates that shorelines retreat, with the greatest risk along coastlines with gentle slope. In the Atlas of Natural Hazards in the Hawaiian Coastal Zone, (Fletcher et al., 2002), the risk of sea level rise along the coast is ranked with the highest risk of 4 given to coastlines with gentle or moderate slope and a relative sea level rise greater than 0.12 in/yr.

In this manual, it is recommended that for coastlines with a sea-level ranking risk of 4 or 3 in the Atlas of Natural Hazards in the Hawaii Coastal Zone, the erosion rate be increased by a default value of 10% (multiplied by a factor of 1.1). Alternatively, a qualified professional consultant can calculate the expected increase in the rate of erosion at the specific site using the Bruun Rule (Komar, et al., 1999), a geometric model, or other generally accepted methodologies utilized in the coastal engineering industry.

This adjustment for sea-level rise is for the anticipated acceleration in sea-level rise and not for historical sea-level rise. The historical sea-level rise should already be factored into the erosion rate analysis since shoreline areas have already been subject to the 20 cm of sea-level rise over the last century (Healy, et al., 2002).

It is a common misconception that all shorelines in Hawaii are eroding due to sea-level rise. As noted by some authors, simple sea-level rise will not elicit immediate shoreline erosion if there is an adequate supply of sand. For example, portions of Kailua Beach on Oahu has been growing wider by half a meter per year over the last 70 years despite a rising sea during the same time period (Norcross et al., 2002). The variability of erosion history for each shoreline sector points out the need for site specific erosion data to determine a suitable setback.

4.1.5 Miscellaneous Adjustments to the Erosion Rate

In addition to the above parameters, there may be unusual circumstances which may require adjustment of the estimated erosion rate. For example, although an erosion rate may be calculated over a 40 to 50 year period, there may be subsequent manmade modifications of the shoreline area which may increase or decrease the erosion rate for an area. The consultant report should discuss the variability of the erosion rate for earlier and later observation periods and if there is a basis for adjusting the rate for future

[14] Interview with Dr. Charles Fletcher, coastal geologist, Dept. Geology & Geophysics, University of Hawaii

projections.

An erosion rate standard deviation, or other method, should be determined to calculate the erosion rate variability (Jones, et al., 2002). The greater the erosion rate variability, the higher the probability that a structure within a setback zone will be undermined. According to the probability tables in the Jones study, a building with a planned setback for 70 years on a shoreline eroding 1 ft/yr with a standard deviation of 1 ft/yr has 10% chance of being undermined after 60 years. Given the same parameters, except that the standard deviation of the erosion rate is 10 ft/yr, the chance that the building with a 70 year setback will be undermined after 60 years is 45%. This significant increase in risk for shorelines with a high standard deviation in the erosion rate should be recognized by the consultant and appropriate adjustments made.

4.1.6 Storm Erosion Event

The coastline of Hawaii can be eroded quickly by very large waves caused by local tropical storms or swell generated by distant tropical storms. A storm event can cause rapid short-term erosion even when there is no long-term erosion trend. The storm erosion event can be estimated in several ways as discussed below:

(1) Probably the easiest method (especially if aerial photographs are being analyzed) is to determine the maximum excursion of the vegetation line inland between any two consecutive observation points as measured on the aerial photographs.[15] If the observation points on the aerial photographs are more than a few years apart, this may underestimate the amount of storm erosion, since there will be significant time for the dune to recover from a storm event. Also, there is the risk that the maximum excursion between any two observation points will combine the storm event and long term trend erosion. This would tend to overestimate the storm event.

(2) The FEMA CCM suggests measuring the setback from the most historical landward position of the ERF (vegetation line in Hawaii). The most historical landward position of the vegetation line may record storm erosion, but may underestimate this factor if a shoreline is subject to both storm erosion and long-term (trend) erosion. This is especially a problem if the major storm occurred relatively early compared to other observation periods and there is long-term erosion.

(3) A geometric model may be useful to determine the maximum erosion during an extreme storm for each specific site (Komar, et al., 1999). The geometric model is based on the slope of the beach face, the vertical shift in the beach profile during the

[15] Interview with Dr. John Marra, Pacific Services Center, NOAA

extreme storm and the vertical distance between the extreme water level and the dune-toe level.

(4) Beach profile data should be considered if it is available for the specific locality (Gibbs, et al., 2001). Beach profiles for Hawaiian Beaches have been collected with a spacing of about a half mile and may not be available for all areas. Furthermore the beach profiles may measure more seasonal changes than dune erosion during an extreme storm event. This is especially true if the beach profiles are taken over a few years and have missed the extreme storm event.

In this manual, the extreme storm erosion event is initially estimated using method 1. A default value is then determined that can then be added to the setback to provide the necessary margin of safety.

From the Atlas of Natural Hazards in the Hawaiian Coastal Zone, (Fletcher, et al., 2002), the highest risk category for the hazard of high waves is for seasonal high waves greater than 12 feet in height and characterized by rapid onset. Also from this Atlas, an area that is in the highest risk category is Sunset Beach on the island of Oahu. Measurements taken from aerial photographs indicate the highest erosion at Sunset occurred during one period between 1967 and 1971, when erosion of the vegetation line and coastal dune was over 10 feet for 7 of 11 transects and over 15 feet for 3 of 11 transects. The maximum recorded erosion was 21 feet (Hwang, 1981; Sea Engineering, Inc., 1988). This erosion is associated with the massive December 1-4, 1969 storm in the North Pacific which generated large swell. When the swell reached the Hawaiian Islands, wave heights approached 50 feet and 14 houses at Sunset were destroyed (State of Hawaii, DLNR, 1970). Based on this event, about 20 feet is hereby used as a general estimate for a storm erosion event statewide. This number is not too large since there were a few sectors on the north shore of Oahu that receded more than 20 feet during the December 1969 storm. Neither is the number too small, since a number of beaches in Hawaii will not be in such a high wave risk category. Nevertheless, these areas are also likely to have smaller dunes than those at Sunset which would provide less protection during storm events.

Ideally, a site specific study would be best, but because of the number of variables, it is often difficult to completely and accurately define the storm erosion potential for a given site.[16] For this manual, the storm erosion event default value of 20 feet is recommended and can be added to the margin of safety factor. An alternative number could be used if a qualified, professional consultant or a government agency can show through the methods outlined above, or through other generally accepted coastal engineering principles that the number should be different for a particular site.

[16] Interview with Scott Sullivan of Sea Engineering

4.1.7 Safety/Design Buffer

A design buffer should be added to the setback, even if there are no errors or risk from sea-level rise. For example, if the life expectancy of a structure is 70 years and the erosion rate is 1 ft/yr, placing the house 70 feet from an eroding shoreline with no margin of safety is risky. Assuming linear erosion and no errors, after 60 years, the structure would be ten feet from the shoreline with ten years of useful life left.

Experience in dealing with homeowners in Hawaii indicates that when a house is closer than 20 feet from the vegetation line, the homeowner is likely to panic. On Maui, when structures are within 20 feet of the shoreline, they are considered threatened and variances to the setback for erosion control measures may be considered. In North Carolina, the 20 foot threshold determines when emergency measures are allowed.[17] It is recommended that at no time during the useful life of a structure, should a residence be within 20 feet of the shoreline. Thus, a margin of safety of at least 20 feet should be added to the setback calculation so at the end of the useful life of a building, the structure is not at the shoreline, but at least 20 feet away.

By utilizing a margin of safety in the design, situations such as shown in Figure 1-11 can be avoided. Furthermore, margins of safety are recommended for other coastal hazards, such as flooding, where FEMA recommends a freeboard of 1-2 feet above the Base Flood Elevation.

The 20 foot safety/design buffer along with the default storm event estimate of 20 feet (Section 4.1.6) combine for a setback of 40 feet. This is comparable to the current State shoreline setback and would be sufficient if there was no risk of long-term shoreline erosion.

4.1.8 Summary of Parameters to Determine the Erosion Zone

With all of the parameters defined, it is now possible to determine the erosion zone. In Table 4-1, the erosion zone is calculated utilizing various erosion rates, and life expectancy of structures. In Hawaii, typical erosion rates are on the order of 0.5 to 1 ft/yr. (Hwang, 1981, Sea Engineering, Inc., 1988, Makai Ocean Engineering, Inc., et al., 1991, and Fletcher et al., 2002).

[17] Interview with Spencer Rogers, North Carolina, Sea Grant

Erosion Rate ft./yr.	Adjusted Rate for Errors (20%)	Adjusted Rate for Errors and Accel. Sea Level Rise (20%) X (10%)	Storm Event	Safety/Design Buffer	Erosion Zone 70-year Life of Structure	Erosion Zone 100-year Life of Structure
0	0.12*	0.13*	20	20	49*	53*
.1	0.12	0.13	20	20	49	53
.2	0.24	0.26	20	20	58	66
.3	0.36	0.39	20	20	67	79
.4	0.48	0.52	20	20	76	92
.5	0.60	0.66	20	20	86	106
1.0	1.20	1.32	20	20	132	172
1.5	1.80	1.98	20	20	179	238
2.0	2.40	2.64	20	20	225	304

Table 4-1 – Extent of Erosion Zone Given the Erosion Rate and Life Expectancy - For areas that are accreting, the erosion rate should be treated as zero, since HRS Section 183-45 prohibits building structures on accreted land. For areas with an erosion rate of 0, the setback is based on an erosion rate of 0.1 ft./yr.* Factors related to the accelerated sea-level rise adjustment or the storm event of 20 feet may be analyzed by a consultant to determine if a different number is warranted for a specific site. If no analysis is done, the default value should be utilized. This analysis assumes no adjustments for erosion rate variability (See section 4.1.5).

It is instructive to compare how the setback for this manual compares with established setbacks in Hawaii and elsewhere.

For Oahu, there is a 60 foot setback for new subdivisions. This would be comparable to the setback for structures with a 70-year life and an erosion rate of 0.2 ft/yr (Table 4.1). However, the fixed 60 foot setback would be too small if the measured erosion rate increases. For example, if the erosion rate is .5 ft/yr, the setback should be about 86 feet.

On October 28, 2003, the Maui Planning Commission passed new shoreline setback rules, which were approved by the Mayor on November 14, 2003. The new rules have a setback of 20 feet plus 50 years multiplied by the erosion rate. This is felt to be an improvement over pre-existing rules, but still, may not be sufficiently protective. For instance, a shoreline with an erosion rate of .5 ft/yr would lead to a setback of 45 feet, which is only slightly larger than the current State setback of 40 feet. Assuming linear erosion, after 50 years, the homeowner would be 20 feet from the shoreline with an estimated 20 years of useful life left in the structure. Thus, the homeowner would be in a threatened situation (See section 4.1.7). Furthermore, this setback would not account for errors, storm erosion events or accelerated sea level rise. This guidebook would create a setback of 86 feet under similar circumstances. Various land use tools or strategies can then be utilized to minimize the impact on the landowner (see Chapter 11 for further discussion).

Originally Maui proposed a setback of 40 feet plus 70 years times the erosion rate for new subdivisions. This would have been comparable to the setback formula in this manual, except the original Maui formula did not include adjustments to the erosion rate for errors and potential acceleration in sea-level rise. Furthermore, for large structures, district reclassifications at the State level (Stage 1) or zoning changes at the county level (Stage 3), a 100 year time frame is recommended instead of 70 years.

North Carolina has established a setback of 30 years times the average annual erosion rate, with a minimum setback of 60 feet. This is similar to the setback in this manual, where an erosion rate of 0 leads to a setback of 49 feet. However, for an erosion rate of 1 ft/yr, the setback would be 60 feet in North Carolina and about 132 feet using this manual. North Carolina is evaluating the suitability of their coastal setback.[18]

Finally, the FEMA CCM calls for a setback around a minimum planning period of 50 years and a minimum erosion rate of 1 foot per year. For an erosion rate of zero, the FEMA CCM would lead to a setback of 50 feet and is close to the 49 feet for this manual. At an erosion rate of 0.5 ft/yr, the FEMA CCM would also lead to a setback of 50 feet, while this manual calculates the appropriate setback at 86 feet.

Generally, when compared to other jurisdictions, the formula in this manual leads to comparable setbacks for no or low erosion rates. For higher erosion rates, the setback is greater due to a longer planning period, which more accurately reflects the expected life of a building and the actual risk on the coastline. From a political point of view, the greater setbacks are made more feasible when they are determined and implemented in the early stages of development (Stages 1-4 in Figures 2-5 and 2-6). This is a significant departure from past practices, in which setbacks are traditionally implemented at Stage 7 in the development process. To further illustrate the ability to implement a large setback in the early stages of development, it should be noted that in the Maui County Zoning Ordinance (Stage 2), there is a requirement for a 300 foot setback for any beach area at Manele.[19]

To make scientifically based setbacks more acceptable, this manual recommends adjustments to the implementation strategy, depending on the specific stage of development to consider legal rights, political realities, fairness and practicality. For example, various permutations of a minimum buildable area for existing residential lots are discussed in Chapter 11 to specifically address the issue with regard to small lots. The use of regulatory incentives is also introduced to deal with the issue of nonconforming structures that later become damaged by coastal hazards. These

[18] Interview with Spencer Rogers, North Carolina Sea Grant
[19] Maui Comprehensive Zoning Ordinance § 19.70.100(A) and (B)(10)

strategies are covered in later sections of the guidebook and summarized in Chapter 13.

4.2 Determining the Wave, Flood and Inland Zones

One advantage of utilizing the wave, flood and inland zones (Figure 3-1) in the overall hazard mitigation strategy is that FEMA has already mapped V, VE, A, AE and X zones on Federal Insurance Rate Maps ("FIRMs"). These flood zones can be used to determine the inland extent of the zones used in this manual. For example, the wave zone in this manual coincides with the V and VE zones on the FIRM. The flood zone would coincide with A, AE and X zones.[20] The inland zone is the area away from the coast that is not in the V, VE, A, AE, or X zones.

Another advantage of using FEMA's designation is that the FIRMs incorporate tsunami and hurricane inundation data into the mapping of the inland extent of the V and A zones. For the islands of Oahu, Maui, Molokai and Hawaii, tsunami inundation boundaries are computed for most of the shoreline. The VE zone boundary is determined where the depth of water from the 100-year tsunami is 4 feet or greater.[21] Water levels that are less than 4 feet identify the A zone on the FIRM.

For the island of Kauai, again, the 4 foot inundation level from the tsunami serves to identify the VE zone. In addition, the southwest coastline of Kauai was restudied to account for severe coastal inundation caused by Hurricanes Iwa (1982) and Iniki (1992). Before these hurricanes, coastal inundation by hurricanes was not considered to be significant.

FIRMs are based on flood insurance studies that are conducted by FEMA. For Oahu, the flood insurance study was updated on November 20, 2000. Kauai's flood insurance was updated on September 30, 1995, Maui and Molokai's on May 15, 2002 and the island of Hawaii on June 2, 1995. These studies are updated on a periodic basis as new data and/or methodologies become available.

There is one shortcoming in relying on the FIRMs to plan for tsunami or hurricane inundation. Inundation from these hazards is mapped only where a section of the coastline has experienced a particular hazard event. As an example, the south coast of Kauai experienced inundation from Hurricanes Iwa in 1982 and Iniki in 1992. The south coast of Oahu has not experienced similar hurricane inundation, although scientists have

[20] The reader should check the building departments at each county for construction standards related to each of the FEMA flood zones.

[21] In most coastal states, the V-A zone boundary is determined where the wave height is greater than 3 feet over the 100-year stillwater elevation. In Hawaii, the V zone is determined where the depth of water from the 100-year flood is greater than 4 feet (See Section 4.4). The 4 foot water depth sustains a 3 foot wave, since wave height is depth limited according to the formula .78 (depth) = height of the breaking wave (August 17, 1977 letter from the Federal Insurance Administration – Flood Insurance Office – Department of Housing and Urban Development).

indicated that a hurricane impact for any of the islands is likely (Schroeder, 1993; Oahu Civil Defense Agency, 2003). Because there is no experience with severe inundation from hurricanes on Oahu, this hazard is not incorporated into the FIRM for Oahu using rigorous technical analysis. Due to this shortcoming, the assessment of tsunami and hurricane risk should rely not only on the FIRMs but on resources such as the FEMA CCM, Atlas of Natural Hazards in the Hawaiian Coastal Zone, or other published reports and field observations. These issues may be resolved by future modernization of FIRMs (see Section 4.4).

V-zone, hurricane and tsunami inundation is likely to be significantly further inland than the erosion zone. At Kahuku Point on Oahu, the V-zone is about 900 feet and the A-zone over 5,500 feet inland. Runup heights of up to 27 feet were recorded for the 1946 tsunami in this area (Lande and Lockridge, 1989; Fletcher et al., 2002). Aerial photographs taken in 1949 show that the sand and debris field believed to be caused by the 1946 tsunami was about 1,200 feet inland (Hwang, 1981). Compare the inland extent of these V and A zones with the erosion zones calculated in Table 4-1.

4.3 The Hazard Assessment

Before major development decisions are made along the coast, it is recommended that a hazard assessment be conducted, with the heart of the assessment being the erosion study (Section 4.1). The erosion study would help to identify the erosion zone. The hazard assessment would also help to determine the wave, flood and inland zone, which would be derived primarily from the FIRMs.

Ideally, local planning agencies could determine the erosion and hazard zones for the entire county at one time. This would ensure that the methodology is uniform, while minimizing the costs to obtain the planning data. The data could then be used for private, State or county projects. However, if such comprehensive studies are not conducted, it is recommended that a retained consultant determine the erosion and hazard zone for each project following set guidelines. This would be preferable to making siting decisions along the coast without information needed for planning on the magnitude of erosion or hazard risks.

A standard for a hazard assessment is described in Figure 4-5. This standard could be followed, or the applicable county agency may choose to refine or develop their own standard.

Standards for the Hazard Assessment

- Determine an erosion rate using existing data, or calculate a rate utilizing standards such as those found in this manual (Figure 4-4).
- Consultants, including those identified in Appendix B and Aerial Photographs identified in Appendix C can be utilized if there are no current studies on the erosion rate.
- Determine the erosion zone with the formula outlined in this manual. The consultant should discuss the applicability of the sea-level rise factor and the storm erosion factor and apply any adjustments if needed.
- Determine the wave (V-VE), flood (A-AE-X) and inland zones through the examination of existing FIRMs. The location of these zones should be adjusted for the potential of erosion (Figures 1-9 and 4-6)
- Superimpose the property boundaries and project footprint on a map along with the erosion, wave (V-VE), flood (A-AE-X) and inland zones.
- Examine relevant reports, such as the Atlas of Natural Hazards in the Hawaiian Coastal Zone (Fletcher, et. al., 2002) to further evaluate all hazard risks at the project site (Chapter 3). Review updated reports or assessments in progress for the State or counties such as those related to wind strength mapping, remapping of flood inundation zones, or refinement of lava flow risk areas.
- Through the review of relevant reports and field observations, determine if hazards other then erosion, bluff erosion and lava should be addressed during the early stages of development (Stages 1-4). In particular, hurricane and tsunami inundation should be assessed to determine if local conditions require these hazards to be avoided through proper siting. Unusual siting issues may also arise next to steep slopes (e.g., wind speed up or landslide/debris flows).
- If critical facilities and infrastructure are proposed in the flood zone, discuss why these facilities are needed there and any mitigation measures to reduce the risk of damage. Critical facilities should not be in the erosion or wave zone.
- Certify that the assessment was conducted by an experienced qualified professional using best professional judgment. A statement should be made that risks to future residents from coastal erosion, wave inundation and flooding have been minimized. Sufficient information should be included on erosion and flooding that will allow the approving county agency to certify that the site is suitable for its intended use, for structures with inhabitants that may be on site for 70 to 100 years (Chapter 8).

Figure 4-5 – Hazard Assessment Standard - Standards for a hazard assessment can be followed for major projects that are up for district reclassification, zoning change or subdivision approval.

4.4 Adjusting the Wave, Flood and Inland Zone Based on Erosion

The erosion study in Section 4.1 may reveal that an adjustment to the position of the wave (V-VE), flood (A-AE-X), and inland zone is warranted (see Figures 1-9, 3-1 and 4-5). This is an evaluation that can be done in the hazard assessment.

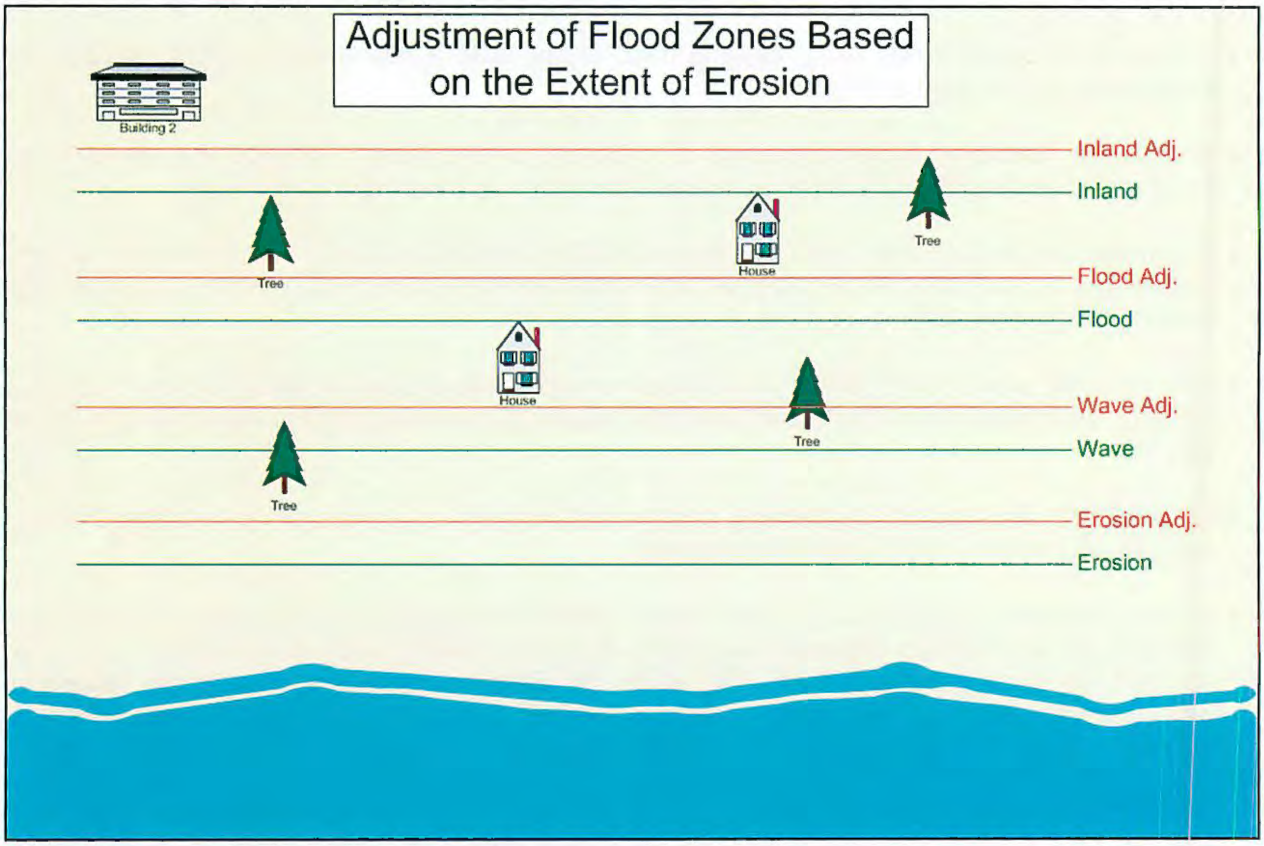

Figure 4-6 – Migration of Flood Zones with Erosion – Over time, erosion may cause the wave, flood and inland zones to migrate inland (see Figure 1-9). The migration of these zones should be accounted for in the hazard assessment. The significance of erosion on location of the flood zones is site specific and depends on factors such as the tsunami height, coastal slope, and surface roughness, among other factors.

The relationship between the horizontal extent of erosion and the migration of the flood zone is complex and requires an explanation of how V zones are determined in Hawaii. For background information on this topic, the reader is referred to the Flood Insurance Studies for each county, and the report "Manual for Determining Tsunami Runup Profiles on Coastal Areas of Hawaii" (M&E Pacific, Inc., 1978).

Many measurements on historical tsunami runup heights were made by investigators at various coastal locations. Based on historical data, a relationship between tsunami elevation and frequency of occurrence was developed for a distance that is 200 feet inland from the shoreline. Thus, for the hundred year event that defines the special flood hazard zone, a tsunami elevation at 200 feet inland from the shoreline can be estimated for any section of the coastline in Hawaii.

With the tsunami elevation at 200 feet from the shoreline ("H"), runup inland of that point can be predicted using equations that relate the inland extent of flooding with

H, the slope of the coastal segment, the roughness of the coastal surface and whether the tsunami wave is a bore or non-bore type (Bretschneider & Wybro, 1976). For example, given a specific tsunami depth of 6 feet at the 200 foot focal point from the shoreline,[22] a coastal slope of 1%, a nonbore tsunami and an average surface roughness number of .045 (typical of rough surface areas with thick grass, trees or brush), it would require about 110 feet from the focal point, or 310 feet from the shoreline, before the tsunami depth decreased to 4 feet. This reflects the fact that the tsunami depth will diminish inland due to the rising ground elevation and friction or decay from roughness of the coastal surface.

Note that the 4 foot water depth for the 100-year event defines the V zone in Hawaii (Section 4.2). Depths that are greater than 4 feet are in the V zone. Depths less than 4 feet to the inland extent of the 100-year flood are in the A zone. The X zone is from the runup limit of the 100-year flood to the runup limit of the 500-year flood.

While the flood zones for most of the coastline in Hawaii are based on tsunami elevation, the south coast of Kauai, from Poipu to Kekaha is based on a combination of tsunami and hurricane data. Flood elevations at the 200 foot focal point for Hurricane Iwa and Iniki were estimated using the Bretshcneider-Wybro wave runup equations and data on inundation limits as indicated by debris lines (U.S. Army Corps of Engineers, 1994). Combining the hurricane and tsunami flood elevation data and using frequency analysis, the flood elevation at 200 feet could be determined for the 100 and 500-year events.[23] The Bretshcneider-Wybro equations are then again used to determine the inland location of the 100 and 500-year events, thus determining the locations of the V, A and X zones.

Erosion may change the location of the flood zones by moving the 200 foot focal point inland a distance equal to the erosion zone. This could move the flood zones inland a significant amount, particularly for coastal areas with very gentle slopes. In the hazard assessment, a qualified professional consultant should determine if there is an impact to the wave and flood zones using the "Manual for Determining Tsunami Runup Profiles on Coastal Areas of Hawaii," or other generally accepted coastal engineering methods.

Each area is different and needs to be evaluated on a case by case basis. Situations of potential concern may be where: (i) there is a very gentle, or no coastal slope, (ii) the erosion zone is relatively large compared to the wave or V zone, (iii) after erosion, relative surface roughness decreases in the space between the 200 foot focal point and the flood zones, (iv) after erosion, relative surface slope decreases in the space between the 200 foot focal point and the flood zones, or (v) a structure in the A zone is in close proximity to the V zone. Situations that may not be of concern would be for structures

[22] The tsunami depth would be the 100 year tsunami elevation minus the ground elevation.

[23] In essence, Hurricanes Iwa and Iniki elevations were treated as tsunami elevations due to the lack of reliable hurricane models to estimate storm frequency elevations from hurricanes in Hawaii. Interview with Steven Yamamoto, Army Corps of Engineers.

that are significantly above the 100-year tsunami elevation. It is up to the consultant performing the hazard assessment to determine the relative importance of each factor for the specific characteristics of the site in question.

The flood zones in Hawaii are based on slightly different methods and data sets depending on the particular section of the coast. While most of Hawaii is based on tsunami elevation and runup, the south coast of Kauai is based on tsunami and hurricane data, and the south shore of Oahu is based, in part, on a 1985 study prepared by Edward K. Noda and Associates for the U.S. Army Corps of Engineers. The Noda study was prepared to support State Civil Defense hurricane evacuation planning and not for establishing 100-year coastal flood elevations. Nevertheless, because the study provided the most current and relevant analysis of the potential coastal flooding due to hurricane wave attack, and the probable inundation was greater than that previously determined for tsunami runup, the FIRM was revised by FEMA to reflect the 100 year zone due to hurricane storm surge/runup.[24]

Discussion with FEMA officials indicate that the FIRM maps for the south shores of the islands may someday be modernized based on hurricane modeling and the generation of a hypothetical 100-year hurricane. Whatever method is used to determine the flood zones in Hawaii, consideration by the consultant should be given to the methodology used to determine the flood zone at the particular site, and the impact of erosion on the location of the flood zones based on the utilized methodology.

The adjustment of flood zones for erosion is not a regulatory requirement of the national or State flood insurance program. It is a proactive measure that the counties, or the proponents of a development should consider in order to reduce the risks of flooding to future occupants. Such an analysis seems appropriate for new or large subdivisions along the coast. If the adjustment is conducted on a consistent basis in the absence of a regulatory requirement, the procedure could become an industry standard.

4.5 Adjusting the Hazard Assessment for Selected Coastal Areas

The agencies can use local knowledge to streamline the hazard mitigation analysis based on the characteristics of the particular coastal site. For example, the County of Kauai could develop policy that in the hazard assessment, earthquake and lava risks do not need to be addressed because the risk of lava on Kauai is nonexistent and earthquake risk is adequately addressed in the building code during the construction stage of development. Conversely, a hazard assessment for a project in the County of Hawaii may require analysis for the risk from lava, earthquakes and subsidence.

Another example of using local knowledge is that the risks from hurricane

[24] Comments from Elaine Tamaye, Edward K. Noda and Associates, Inc.

inundation are greater along the south coasts of the islands. This is one reason that FEMA may modernize the flood mapping for the south coasts of the islands. Tsunami elevation and inundation data continue to be the main determinant for the flood zones on east, west and north facing coastlines.

Given the particular section of the coastline, the counties should be able to provide further guidance as to what are appropriate issues to address in the hazard assessment.

4.6 Adjusting the Hazard Assessment for the Stage of Development

Depending on the stage of development, the hazard assessment should be adjusted so that it is appropriate for a particular project. A 40 acre subdivision with hundreds of potential residents may require one level of analysis (Stage 4), while the building of a single house on an infill lot may require another (Stage 7).

In cases where a full blown assessment may be inappropriate (e.g., the infill of a single house on an existing improved lot) an abbreviated analysis may be in order. Since an infill lot is likely to have many existing residences nearby, hazard mitigation issues and solutions may already have been identified by the agencies. This knowledge may negate the need to analyze all hazards.

For small structures proposed on an infill lot (Stage 7), it may be appropriate to streamline the erosion study. For example, the erosion study may utilize aerial photographs every ten years, instead of every five. In addition, an erosion rate can be calculated using the very earliest quality aerial photo, and the most recent aerial photo (end-point calculation versus linear regression).

In Table 4-2, an example is provided of how the level of hazard assessment can be modified, given the particular stage of development. Three levels of analysis are proposed that consider the usefulness of the hazard information, the resources of the parties and the practicality of the assessment request, given the particular stage of development. This scheme can serve as a guide on the appropriate level of assessment for projects in various stages of development.

It is up to the individual counties to decide if the assessment scheme in Table 4-2 should be more or less stringent. A more strict provision would require a full erosion study (Level 2 Assessment) for even small structures on infill lots (Stage 7). A less strict provision may require no hazard assessment for a change to the general or community plan (Stage 2), provided language in the plan states that one must be conducted for any zone change, subdivision or infrastructure approval.

Development Stage	Level 3 Assessment	Level 2 Assessment	Level 1 Assessment
District Classification (1), General or Community Plan (2), Zoning (3), Subdivision (4), Infrastructure Improvement (5)	Conduct Erosion Study (Figure 4-4) with Hazard Assessment – (Figure 4-5).		
Infill Lot (7) – Large Lot & Structure	-	Erosion Study – follow guidance in Figure 4-4.	
Infill Lot (7) – Small Lot & Structure	-	-	Erosion Study – follow guidance in Figure 4-4 except aerial photographs every ten years – end point analysis.

Table 4-2 – Modification of Hazard Assessment with the Stage of Development - Counties should modify the level of the hazard assessment for the specific coastal project depending on the stage of development that the project is in. An erosion study would not be needed for any of the levels of assessment if there is suitable existing data.

Once the hazard assessment is completed for a particular development stage, it can be utilized for all subsequent development stages. Ideally, the assessment should be conducted at the earliest land use opportunity that a project is up for approval. Because of the factors discussed in Figure 2-5, it is preferable that the hazard mitigation be addressed in Stage 1 versus Stage 2, or Stage 3 versus Stage 4.

The hazard assessment proposed in this chapter can be distinguished from a Risk and Vulnerability Study that is commonly used in the hazard mitigation community. A Vulnerability Study determines the existing structures in a hazard area, the threat of natural hazards to those structures and the measures that can be taken to reduce risk to life and property ranging from structural design changes to evacuation measures. The hazard assessment in this Chapter determines the threat of various hazards to a coastal area, but is tailored to provide information before development proceeds so that unnecessary risks can be avoided by proper siting and design.

Chapter 5 – State Land Use Districts (Stage 1)

Although likely to be similar, each state has established a slightly different structure of land use control. For any state interested in hazard mitigation, the first step is to determine a hierarchy of development (Figures 2-2 and 2-5). For Hawaii, the top stage in the development hierarchy relates to the classification and reclassification of land districts, which is a zoning scheme.

5.1 Role of the Hawaii State Plan in State Reclassification Decisions

If the Hawaii State Plan were actively revised, then this plan would be the top development stage in the hierarchy. Nevertheless, the Hawaii State Plan does contain goals, objectives and policies that influence the land-use district classification stage.

In the Hawaii State Plan, the following policies affect State land-use decisions and are related to the goals of this manual:

1. Ensure compatibility between land-based and water-based activities as well as natural resources and ecological systems.[25]

2. Manage natural resources and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage.[26]

3. Encourage the design of developments and activities that complement the natural beauty of the islands.[27]

4. Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, volcanic eruptions, and other natural or man-induced hazards and disasters.[28]

5. Coordinate state, county, federal and private transportation activities and programs toward the achievement of statewide objectives.[29] (*The planning of transportation systems is important in hazard mitigation since the location of roads and utilities often determine the layout of subsequent development.*)

6. Promote design and location of housing development taking into account the physical setting, accessibility to public facilities and services, and other

[25] Haw. Rev. Stat. § 226-11(b)(2)
[26] Haw. Rev. Stat. § 226-11(b)(4)
[27] Haw. Rev. Stat. § 226-12(b)(5)
[28] Haw. Rev. Stat. § 226-13(b)(5)
[29] Haw. Rev. Stat. § 226-17(b)(2)

concerns of existing communities and surrounding areas.[30]

7. Promote the recreational and educational potential of natural resources having scenic, open space, cultural, historical, geological, or biological values while ensuring that their inherent values are preserved.[31]

Some priority guidelines in the Hawaii State Plan that are also relevant to proper coastal development and consistent with this manual are:

1. Direct future urban development away from critical environmental areas or impose mitigating measures so that negative impacts on the environment would be minimized.[32]

2. Identify critical environmental areas including scenic and recreational shoreline resources, open space and natural areas.[33]

3. Utilize Hawaii's limited land resources wisely, providing adequate land to accommodate projected population and economic growth needs while ensuring the protection of the environment and the availability of the shoreline, conservation lands, and other limited resources for future generations.[34]

4. Protect and enhance Hawaii's shoreline, open spaces and scenic resources.[35]

Land use decisions made by State agencies are required to conform to the goals, objectives and policies in the Hawaii State Plan and utilize the priority guidelines within the Act as well as follow the State Functional Plans approved in the Chapter.[36] Thus, the policies and priority guidelines in the Hawaii State Plan that are recited above influence and guide State district reclassification decisions.

5.1.1 State Functional Plans

The State Functional Plans are part of the Hawaii State Planning System and set forth policies, guidelines and objectives within a specific field or activity. In Hawaii, there are twelve such plans with the ones relating to conservation lands, housing, recreation and transportation being the most relevant. These plans were last updated in 1991. If they are updated in the future, specific policies, guidelines and objectives

[30] Haw. Rev. Stat. § 226-19(b)(5)
[31] Haw. Rev. Stat. § 226-23(b)(4)
[32] Haw. Rev. Stat. § 226-104(b)(9)
[33] Haw. Rev. Stat. § 226-104(b)(10)
[34] Haw. Rev. Stat. § 226-104(b)(12)
[35] Haw. Rev. Stat. § 226-104(b)(13)
[36] Haw. Rev. Stat. § 226-52

relating to coastal erosion and hazard mitigation should be included. Suggested policies, objectives, and implementation measures for planning documents are included in Chapter 6.

5.1.2 County General and Development Plans

The Hawaii Planning System also includes the county general and development plans. Since these plans are actively updated at the county level, the role of these documents in hazard mitigation is important and discussed in Chapter 6, which covers Stage 2 of the development process relating to localized community planning.

5.2 Role of State District Boundary Classification in Hazard Mitigation

The State district reclassification process is vital in hazard mitigation because at this development stage, the land is likely to be raw unimproved land, with little or no prior government approvals. As a result, design and expenditures for hazard mitigation will not conflict with prior designs or permitting approvals. From the landowner's viewpoint, early hazard mitigation design is the most fair, efficient, unobtrusive and politically acceptable means of optimizing land values and safety.

5.2.1 State District Classification System

In Hawaii, the four major State districts are conservation, rural, agriculture and urban. In general, conservation districts include areas necessary for protecting watersheds and water resources, preserving scenic and historic areas, providing beach reserves, preventing floods and soil erosion, and preserving areas of value for recreational or conservation purposes.[37] Rural districts are characterized by low density residential lots of not more than one house per half acre in areas where "city-like" concentration of people, structures, streets and urban level of services are absent.[38] Agricultural districts are to include uses characterized by the cultivation of crops, orchards, forests, farming activities and related uses which support agricultural services.[39] Finally, there is the urban district, which is generally characterized by a high concentration of structures, people and streets.

Standards in the Land Use Commission ("LUC") rules provide that conservation lands must include lands necessary for the conservation and preservation of unique ecological resources.[40] Conservation lands shall also include lands with topography,

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[37] Haw. Rev. Stat. § 205-2(e)
[38] Haw. Rev. Stat. § 205-2(c)
[39] Haw. Rev. Stat. § 205-2(d)
[40] Haw. Admin. Rules § 15-15-20-4

soils, climate, or other related factors that may not be normally adaptable or presently needed for urban, rural or agricultural use.[41] Conservation districts may include "lands susceptible to floods and soil erosion, lands undergoing major erosion damage and requiring corrective action by the state and federal government, and lands necessary for the protection of the health and welfare of the public by reason of the land's susceptibility to inundation by tsunami and flooding, to volcanic activity and landslides."[42] Erosion, flooding, landslides and volcanic activity may make some lands not adaptable for urban use. Thus, there is established authority for hazard mitigation to be implemented during the State district classification process.

For the zones identified in this manual (Figure 3-1), erosion, flooding and tsunami inundation is likely in the erosion zone, while flooding and tsunami inundation would be found in the wave (V-VE) and flood (A-AE-X) zones. These hazards provide a basis to retain land as conservation. For the purposes of hazard mitigation, areas necessary to prevent flood, inundation and erosion problems should be kept as conservation land if the issue cannot be adequately addressed during the construction stage of development.

District boundary amendments of more than 15 acres are processed by the State Land Use Commission. District boundary amendments of less than 15 acres are determined by the appropriate local land use authority, except that all changes to conservation land are determined by the State Land Use Commission.[43]

5.2.2 State Land Use District Boundary Amendments

The process to analyze a district boundary change from a low density use to a medium or high density use is depicted in Figure 5-1.[44] This Figure illustrates that an initial hazard assessment would allow the identification of the erosion, wave (V-VE), flood (A-AE-X) and inland zones (See Chapters 3 and 4). Other hazards could be assessed for key siting issues given the local conditions at the site.

The agencies have the authority to ask for such an assessment. Under the LUC rules, a petition for a boundary amendment requires an assessment of the objective and policies of the CZM program, HRS, chapter 205A.[45] An objective of the State CZM Act is to "Reduce hazard to life and property from tsunami, storm waves, stream flooding,

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[41] Haw. Admin. Rules § 15-15-20-7
[42] Haw. Admin. Rules § 15-15-20-2
[43] Haw. Rev. Stat. § 205-3.1
[44] For purposes of discussion only, the terms "low density," "medium density," and high density are used loosely to compare the number of structures allowed in different districts or zones. For example, conservation land can be considered to be open or a low density use since some structures may be allowed in the district with the proper permit. Rural and agricultural areas are considered medium density use, while the urban areas would be considered in this report to be a higher density use.
[45] Haw. Admin. Rules § 15-15-50

erosion, subsidence and pollution."[46] Under the same Act, it is a policy to, "Control development in areas subject to storm waves, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards."[47] Thus, a hazard assessment would help determine if the petition for boundary change is in conformance with these hazard mitigation policies and objectives.

Once the hazard assessment is completed, the erosion, wave (V-VE), flood (A-AE-X) and inland zones can be superimposed on a map with the property tract boundaries and project boundaries. Needed critical facilities should be identified.

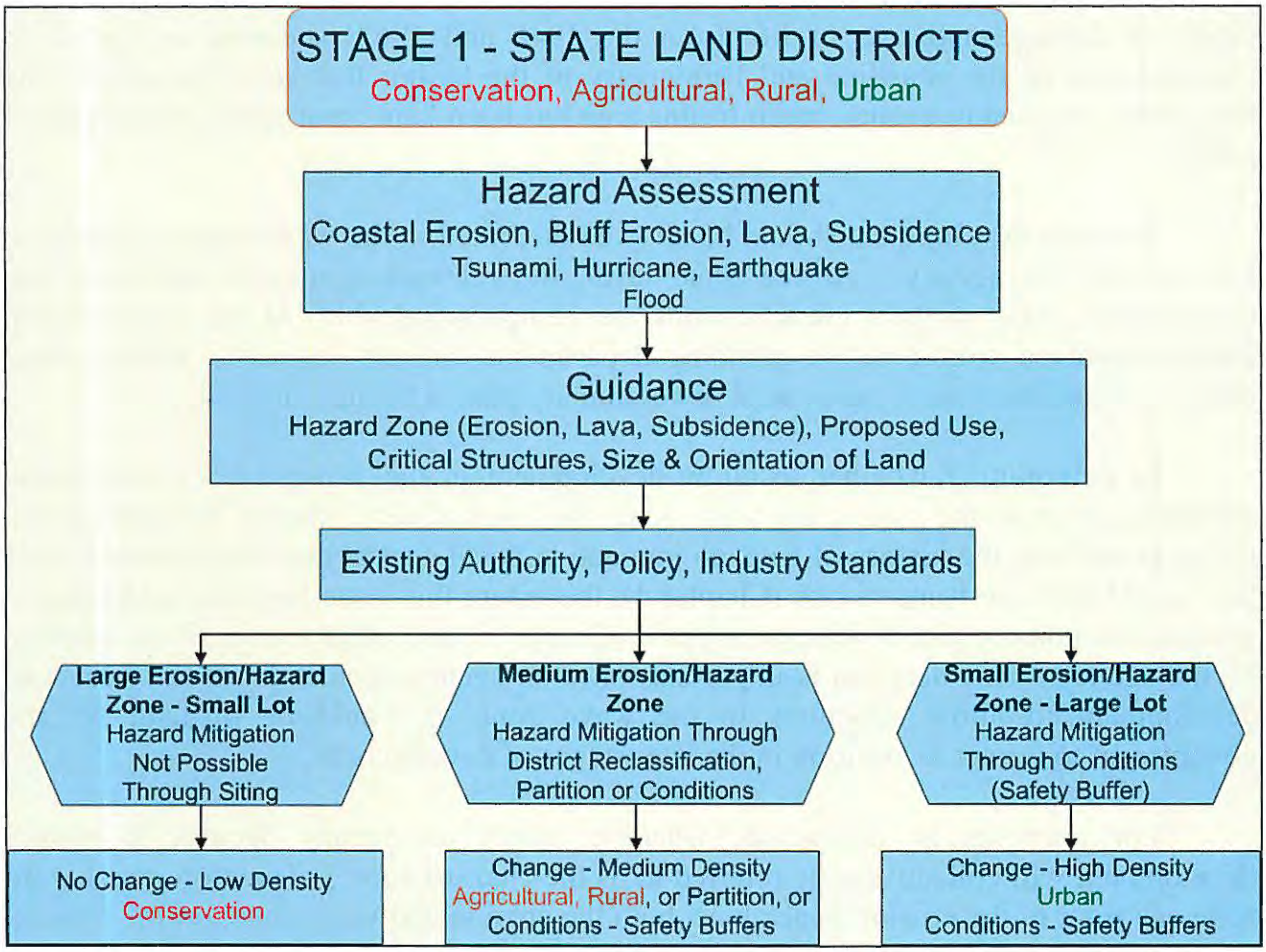

Figure 5-1 – State District Classification Decision Tree - Decision process for a hypothetical land use district change that is currently at a low density and seeks to convert to a medium or high density use at the State level.

Next, the appropriate agency must decide how it will approach the particular scenario. Guidance provided in this manual, or in other referenced reports may assist in the decision making process. At a minimum, new permanent structures should be

[46] Haw. Rev. Stat. § 205A-2(b)(6)(A)
[47] Haw. Rev. Stat. § 205A-2(c)(6)(B)

avoided in the erosion/hazard zone. Critical facilities should be avoided in the erosion, wave (V-VE) and flood (A-AE-Z) zones, unless they are water dependent or the wave and flood risks can be addressed through proper construction and design.

Suggestions have been made to avoid development of new permanent structures in the tsunami inundation zone (equivalent to the wave (V- VE) and flood (A-AE-X) zones in this manual).[48] Due to the large inland extent of these zones, this may be difficult, although the hazard assessment should determine if there are any local conditions that increase the risk of tsunamis that would justify avoidance. An example of one area in which the tsunami zone has been avoided is the Hilo Waterfront in Hawaii. Due to the extensive damage and loss of life from the 1946 and 1963 tsunamis, as well as a configuration of the coastline and bathymetry of the harbor that serve to amplify the magnitude of tsunami events, much of this area has been kept open space in the form of parks.

Whether development should be allowed or denied in the wave zone is a decision for the relevant agency. At the State level, the relevant agency is the Land Use Commission, when district classifications are being considered. At the county level, entities involved would be the planning departments and city councils, when a zone change or modification of the general or community plan is being evaluated.

In determining whether to allow development in the wave zone, consideration should be given to the size of the wave zone, the level of development in nearby areas, the proposed use, the history of tsunami inundation, local coastal and bathymetric factors that would increase tsunami risk (Chapter 4), the extent this issue has been addressed in general, community and development plans (Chapter 6) and other factors found relevant by the agency. This decision is important--once an agency decides in an early stage of development to allow structures in the wave zone, it would be difficult for the government to retract its position in the later stages of development.

For purposes of discussion, whatever zones an agency decides to restrict development will collectively be referred to as the "hazard zone." Therefore, the hazard zone can refer to the erosion zone alone, both the erosion and wave zone, or, the erosion, wave and flood zone collectively.

As shown in Figure 5-1, using the State's existing authority,[49] policy,[50] or industry standards (see Chapter 2), a decision can be made whether to change from conservation land, to medium density agricultural or rural land, or to high density urban land. For small lots with a large erosion or hazard zone, it maybe appropriate to keep the land

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[48] Kauai General Plan – p. 2-12; North Shore Sustainable Communities Plan – Chapter 4, § 4.6.1

[49] Haw. Rev. Stat. § 205-2(e); Haw. Admin. Rules § 15-15-20

[50] Hawaii State Plan, Hawaii CZM Act – Haw. Rev. Stat. § 205A-2(c)(6)(B), or new policy developed by the agency.

conservation (lower left portion of Figure 5-1).[51]

For instances where the lot is larger and the erosion or hazard zone is not as great (lower middle portion of Figure 5.1), there are three options: first, the land can be changed to a medium density use such as agriculture or rural; second, the land can be partitioned, with the erosion or hazard zone remaining conservation, while the areas outside are changed to urban; finally, the land can be changed to urban with a safety buffer as a condition that runs with the land. The later two options are preferable since a change to medium density use alone could allow widely-spaced structures to be built in an erosion or hazard zone.

In the instance where the lot is very large and the erosion or hazard zone is relatively small (lower right portion of Figure 5-1), the most likely scenario is that a change in district to urban would be acceptable with conditions for hazard mitigation, such as an adequate safety buffer, that run with the land.

Changing the hypothetical slightly, if the original land starts out in a medium density use (agricultural or rural), and there is a petition to convert to high density urban, the preferred alternative for hazard mitigation is to have conditions for a safety buffer that run with the land. Partitioning the land with medium density use for the erosion or hazard zone and high density use inland may not be suitable because development would still be allowed in erosion and hazard zones. For the same reason, the alternative of no district change may not be protective.

It should be noted that conditions on redistricting may be made to run with the land, rather than being personal to a specific owner or lessee of such lands.[52] Once specific conditions for hazard mitigation are set by the Land Use Commission, they can be made to be binding during all subsequent development stages and for each and every landowner, lessee, sub-lessee, grantee, assignee or developer.[53] This is an important strategy for propagating hazard mitigation measures down the development hierarchy (Figure 2-5 and 2-6).

The relationship of the lot to the different hazard zones will determine if a change in districts is warranted. Key in the decision is the size of the original lots, their orientation, the size of the hazard zones and the proposed uses. Generally, the key relationship is the percent of the lot that overlaps the erosion/hazard zone. Figures 5-2 through 5-5 illustrate the situations that may arise and how these issues can be resolved.

[51] It is still possible to build a home in the conservation district. When a conservation district permit is applied for, the issue of erosion and hazards can be addressed. Thus, the LUC is only indirectly involved in siting issues and the DLNR would play a key role in where a structure is actually built. See Table 2-1.

[52] Opinion Attorney General's office no. 72-8 (1972)

[53] Haw. Admin. Rules § 15-15-91

In Figure 5-2, there are two lots of different sizes in which the erosion, wave (V-VE), flood (A-AE-X) and inland zones are superimposed. The erosion zone consumes a greater percent of Lot A's footprint. Since erosion is a siting issue that cannot be adequately addressed during the construction stage, the area should be kept as low density conservation land, as opposed to changing to a high density urban use. Conversely, Lot B can be: (i) changed to urban with conditions for a safety buffer, or (ii) partitioned so that land in the erosion zone remains conservation, while the areas outside are urban, or (iii) changed to a medium density use such as rural. A factor to consider in evaluating these options is if provisions in the conservation or rural zones may still allow construction in the erosion zone, leading to unacceptable hazard risks.

If the agencies were ever to consider a prohibition to building in the erosion and wave zones, a possible scenario would be that Lot B would be partitioned with areas in the erosion and wave zones remaining conservation, while areas outside change to urban. Such a prohibition is likely to be rare and justified only in the circumstances where a hazard assessment determines an area to be of unusually high risks and such risks cannot be properly mitigated through construction techniques.

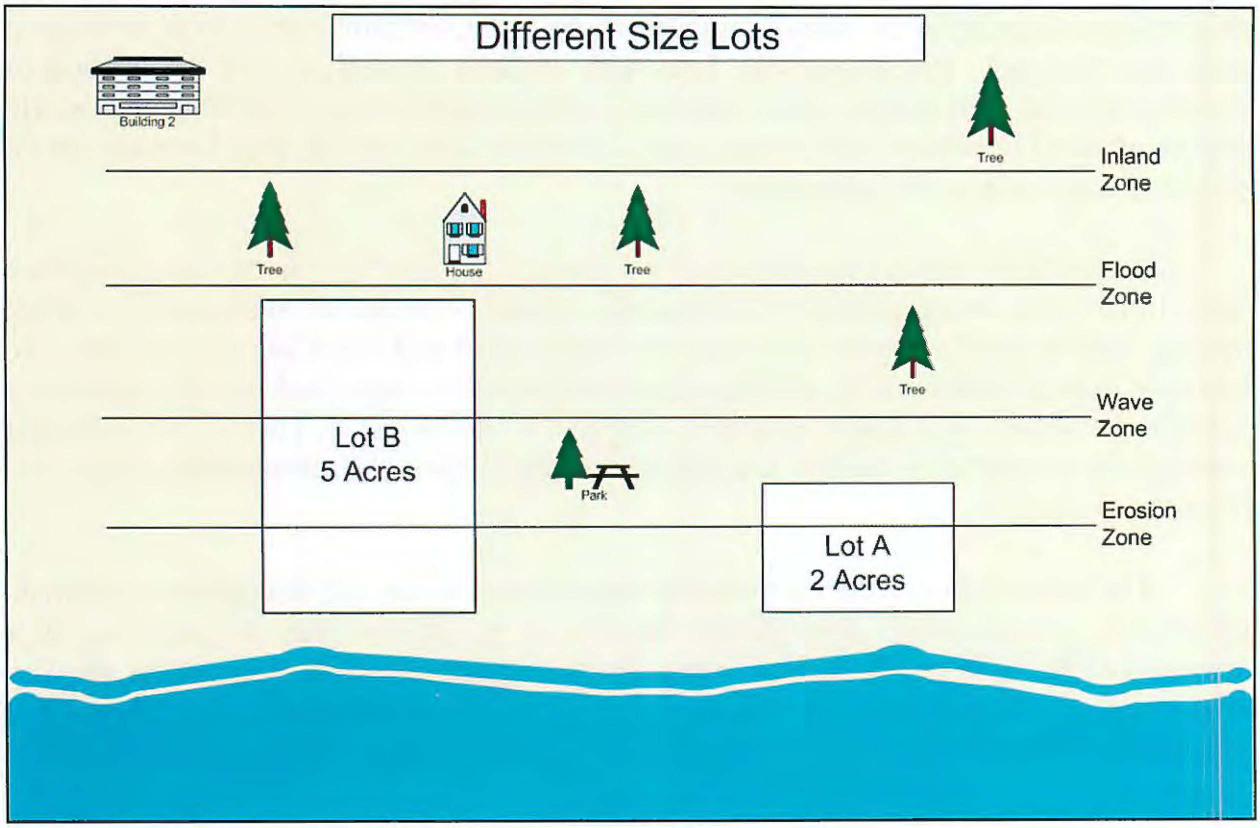

Figure 5-2 – Different Size Lots – Effect of the erosion, wave (V-VE), flood (A-AE-X) and inland zone (see Chapters 3 & 4) for two different size lots. The percent of the lot in which building would be restricted is a key factor in determining how to change the particular land district.

In the next diagram, there are two equal size lots with a different orientation to the shore (Figure 5-3). For lot A, the erosion zone consumes nearly the entire lot. It would be appropriate to keep this area conservation. The erosion zone for lot B occupies only the seaward third of the lot. The wave and erosion zones occupy less than half of the lot. A change to a higher density zone may be warranted with proper conditions for hazard mitigation that run with the land. Suitable conditions may include a setback buffer zone for the erosion zone, some restrictions on size of structures or standards of construction in the wave zone, and a prohibition of critical facilities in the erosion, wave and flood zones. Alternatively, Lot B could be partitioned with the appropriate portion remaining in the conservation district.

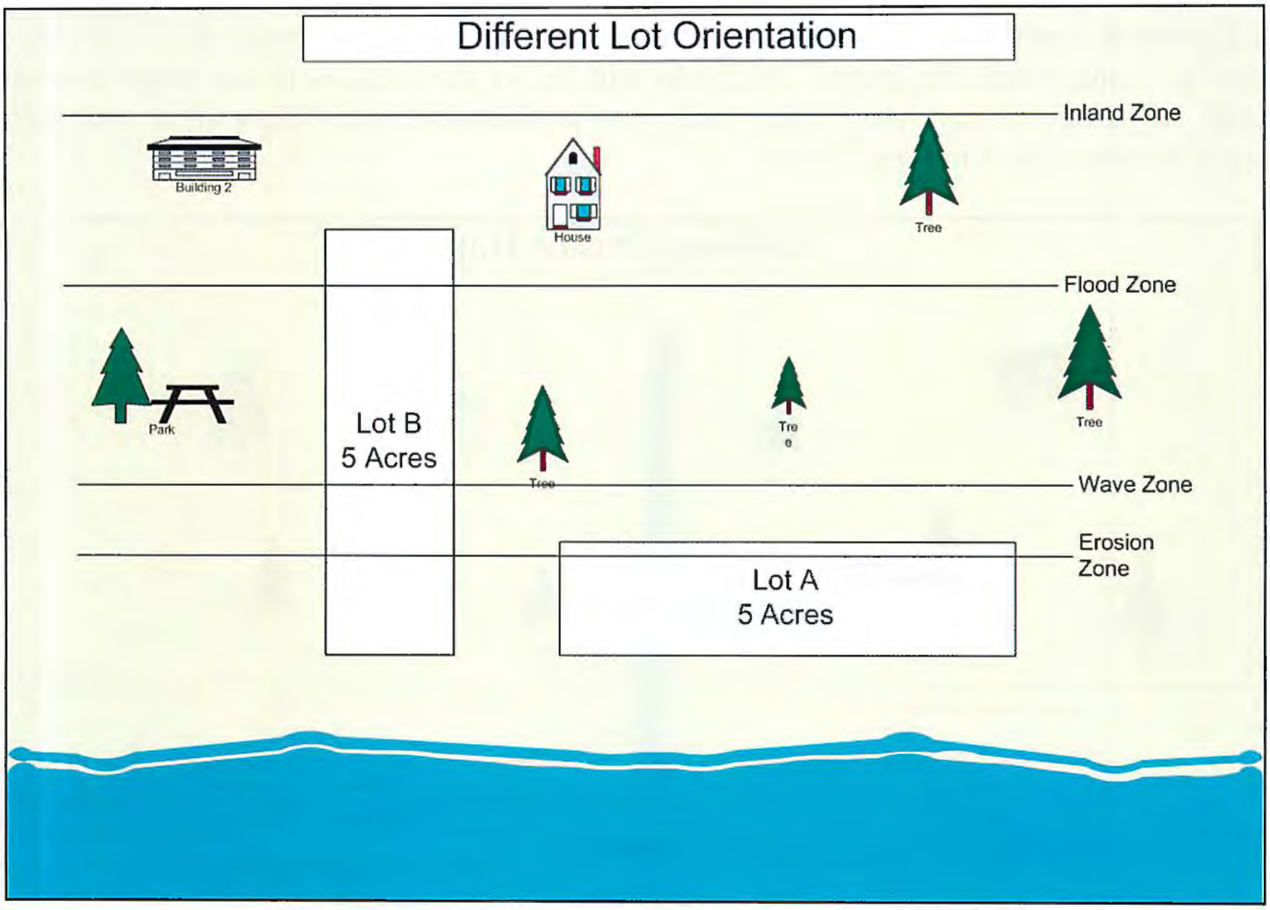

Figure 5-3 - Different Lot Orientation – Effect of the erosion, wave, flood and inland zone for two lots with different orientation. The different orientations may result in a different outcome for a hypothetical district reclassification from conservation land to high density urban land.

In Figure 5-4, there are two geographically different areas with different erosion rates. The different rates will result in one area having a larger erosion zone than the other area. Many States reduce erosion rate variability by averaging erosion rates over a number of transects, (e.g., 3 to 15 transects on either side of the main transect of interest). This procedure ensures that there are not wild swings in the erosion rate from one property to the next. Nevertheless, erosion rates will vary from one geographically separated area to the next. For Figure 5-4, the erosion rate and thus erosion zone are greater for Lot A than for Lot B. Thus, it would be more appropriate to keep Lot A in a low density use, or to partition the land so that the portion in the erosion zone remains conservation. For Lot B, partitioning of the land or a safety setback as a condition to change to high density use may be appropriate.

In Figure 5-4, the wave (V-VE) and flood (A-AE-X) zones are an equal distance inland for both lots while the erosion zones differ. This is because the erosion zone is a product of the predicted average annualized erosion rate times a certain planning period into the future (70 or 100 years). Conversely, the wave and flood zones are determined by current hydrologic conditions. Nevertheless the wave and flood zones may migrate inland with erosion as depicted in Figure 1-9 and discussed in section 4.4. All other factors being equal, the greater migration will be for the areas with the larger erosion zone or greater erosion rate. This is one more justification for avoiding areas with high erosion rates (Lot A in Figure 5-4).

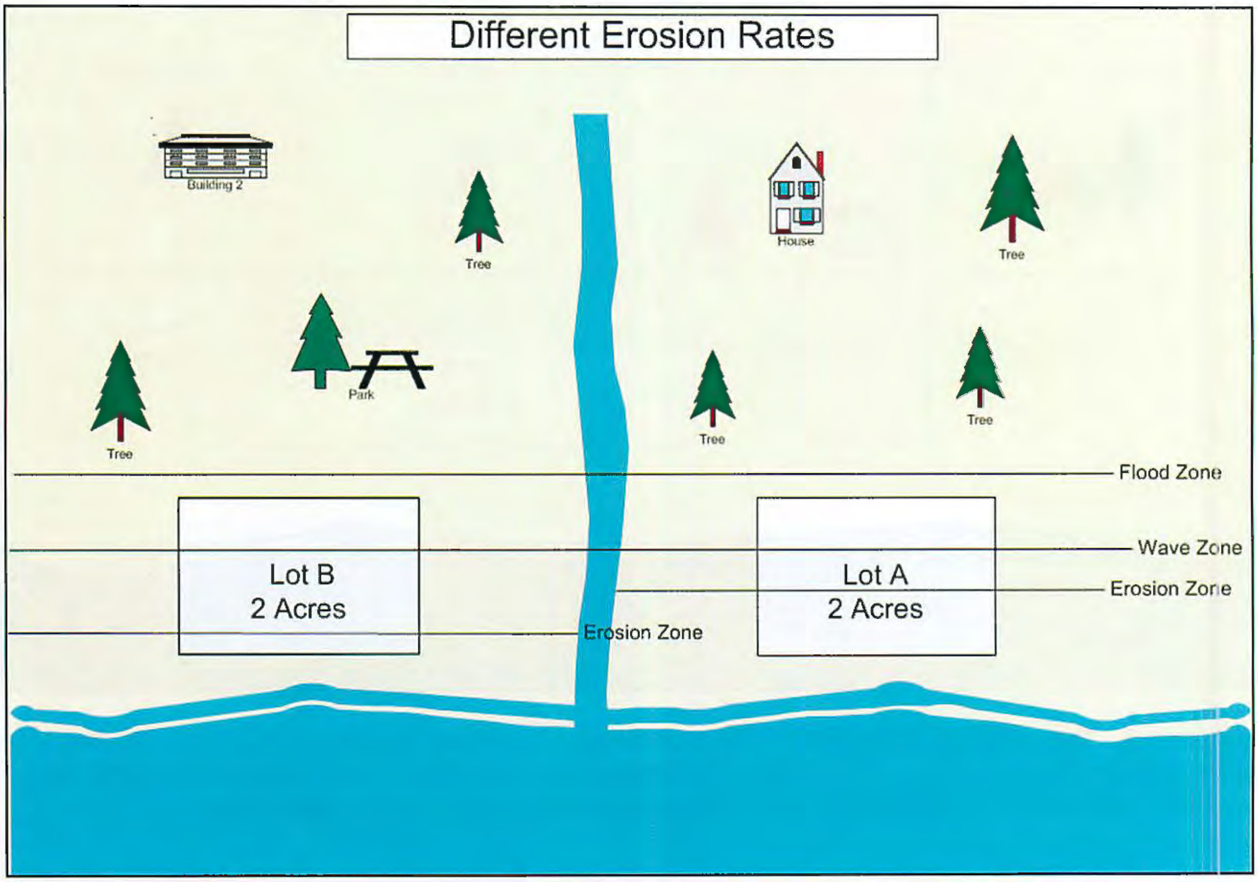

Figure – 5-4 - Different Erosion Rates - Two geographically separated areas with different erosion rates. Lot A has a higher erosion rate which results in a larger erosion zone.

An additional factor in the decision to change district classification is the proposed use of the area (Figure 5-5). As discussed in Chapter 4, the planning period for new subdivisions with small wood frame structures is recommended to be 70 years. The planning period for larger structures, (which are more likely to be made of stone), or for district reclassification or zoning changes in which the exact use has not been determined is recommended to be 100 years. Given two lots with similar erosion rates, the lot with the 100 year setback will have a larger erosion zone than the lot with the 70 year setback. For small temporary or movable structures, in which there are no inhabitants, an erosion zone setback may not be necessary. From this Figure, a reclassification of districts should factor in the proposed uses, since this will determine the size of the erosion zone, and therefore, the percent of the lot in which construction could be affected.

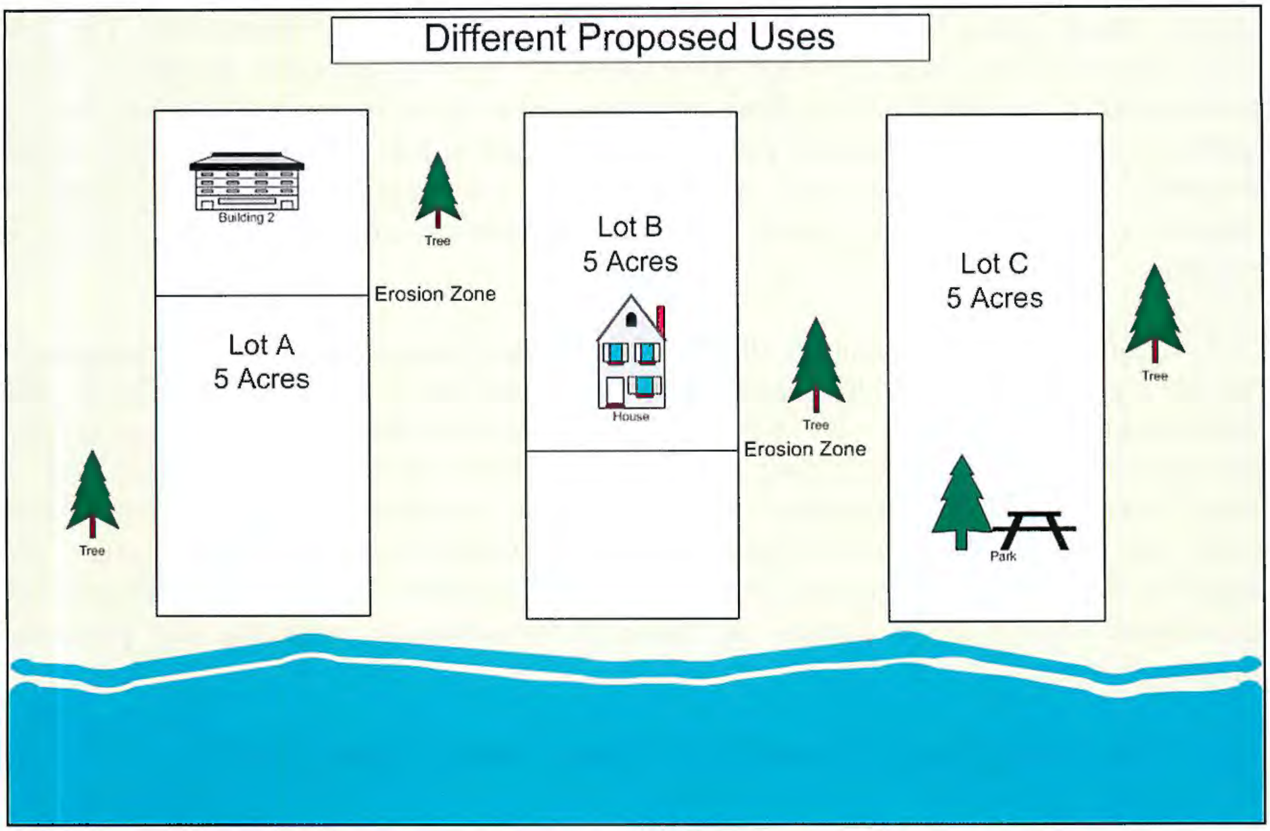

Figure 5-5 – Different Uses - Different proposed uses may change the size of the erosion zone. An appropriate planning period for a large commercial structure, such as on Lot A is 100 years. For a residential subdivision with smaller structures, 70 years is recommended. For movable, expendable or uninhabitable structures, no setback may be needed.

5.3 Home Rule

Land regulation frequently raises questions of conflict between the State and the counties known as "Home Rule." Generally, the State has delegated land use authority to the counties.[54] However, some authority to regulate land has been reserved at the State

[54] Haw. Rev. Stat. § 46-4

level. When the State is involved in land use decisions, the counties may claim that the State has overstepped its authority on an issue of county concern.

As the State makes decisions with reclassification of districts and the mitigation of coastal hazards, concern for Home Rule can be addressed by actively involving the counties in land use decisions.

The State should play a role in coastal development decisions for several reasons. Since the beach system (State jurisdiction) and the dune system (county jurisdiction) are intimately interrelated, it is a misconception to believe development can occur anywhere within county jurisdiction without impact to the beach resources (Figure 1-1). The loss of the beaches from close development (Figures 1-5 and 1-6) provides the State a direct interest, since the beaches are a State resource. Even more important, the State has an interest in hazard mitigation and preventing the threat to life and property from coastal hazards.[55] By preserving dune systems, erosion of the shoreline and flooding of backshore areas can be mitigated. These are legitimate goals of the State and the counties.

Planning for hazards at the district classification stage provides a rare opportunity for the agencies to mitigate hazard risks at a time that is most effective and least burdensome for all parties. To take advantage of this opportunity, the State and county should work together so that county concerns about Home Rule can be addressed while a parcel undergoes a district change. For all boundary amendment petitions at the State level, the planning commission and planning department of the respective county are required to be notified.[56] By law, the State planning and the county planning department are required to appear as parties and make recommendations regarding any proposed boundary change.[57]

5.4 State District Boundary Change at the County Level

For parcels less than 15 acres that are classified agriculture, rural or urban, the individual county councils may decide on the boundary change as opposed to the State Land Use Commission. The analysis for determining the change is similar to the change for conservation land described above and would follow the concepts in Figures 5-1 through 5-5. It is important that the counties actively seek input from the State on proposed reclassifications for coastal property.

The applicant of the land use district reclassification may need to provide information on environmental impacts, the type of project proposed, drainage, soil

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[55] Hawaii State Plan – Haw. Rev. Stat. § 226-13(b)(5)
[56] Haw. Admin. Rules § 15-15-51
[57] Haw. Rev. Stat. § 205-4(e)(1)

conditions, traffic or demographic studies, an environmental impact statement (if required), and facts indicating the Hawaii CZM Act was followed (HRS Chapter 205A).[58] Thus, at the county level, it would be appropriate to ask for a hazard assessment for district reclassifications.[59]

For Kauai, a change to an urban district would require land to be reasonably free from the danger of flooding, tsunamis, unstable soil conditions and other adverse environmental effects.[60] Conditions for hazard mitigation can be put on the parcel at the county level and can be made to run with the land.[61] This is accomplished by recording the conditions in the Bureau of Conveyances, or filing with the assistant registrar of the Land Court.

5.5 Regulatory Takings, Police Power, Political and Fairness Issues

The authority of the agencies to avoid development in hazard zones at Stage 1 is generally, at its greatest for several reasons. First, the landowner's reasonable investment backed expectations are the lowest compared to any other development stage (Figure 2-5, col. 2). Second, incorporation of any safety buffer will have the least economic impact on the landowner compared to other development stages (Figure 2-5, col. 1). Third, mitigation measures to be implemented are unlikely to conflict with prior approvals, permits or designs. Fourth, because the land has not yet been subdivided, tracts of land will generally be large compared to any needed safety buffer. While each parcel will have its own special circumstances, in general, the larger tracts brought up for district reclassification will be able to accommodate buffers with little economic impact to the landowner.

For the above reasons, any scientifically based mitigation measures that the county or State feel are needed for the proper mitigation of hazards should be addressed at Stage 1, and not be passed to lower development stages. For instance, requiring a 100-year setback, or preventing construction in the wave zone is a decision that may be proper for Stages 1 through 3, but may be inappropriate during the subdivision stage (Stage 4).

It is unlikely that addressing hazard mitigation at Stage 1 will lead to a legitimate takings claim, unless the land is down zoned, which is generally not recommended in this manual. Due to the significant government authority agencies have to regulate land for objectives related to protection of life and property from coastal hazards (Appendix D), the agencies should not resort to compensation if it is well within their police power to address the problem.

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[58] Kauai County Code § 11-2.3

[59] For example, the planning director in Maui County may ask for other information in an application to change State District Boundaries - Maui County - Comprehensive Zoning Ordinance § 19.68.020(B)(10)

[60] Kauai County Code § 11-4.1(c)(3)

[61] Kauai County Code § 11-4.2 - Maui County - Comprehensive Zoning Ordinance § 19.68.040(B)

In the rare circumstance in which compensation may be warranted, land will generally have the least market value when compared to other development stages (Figure 2-5). This allows land-use tools such as acquisition, land swaps, lease purchase, purchase of development rights (PDRs) and transferable development rights (TDRs) to be far more feasible and effective as a tool to avoid coastal hazards and provide compensation.

While a "regulatory taking" issue is unlikely to arise, an agency overseeing a district classification can follow several guidelines to protect itself from legitimate claims. These include: (i) avoid down zoning (i.e., change from an existing high density use to a lower density use); (ii) provide a process to oversee special circumstances and evaluate appeals or variances; and (iii) be wary of building prohibitions that consume the entire tract of land and leave no economically viable use. If these issues arise, the compensation tools listed above may be warranted.

Even if there is no regulatory takings issue, compensation options may be desirable, for the sake of fairness or political support to obtain a restrictive land use. While these may be valid reasons to provide compensation, all parties involved, including the public, should know that the agencies at the State district reclassification stage have very broad regulatory authority to mitigate the risks from coastal hazards without having to pay compensation.

While a government decision may not approach a takings claim, a measure of fairness should also be a part of all development decisions. If a safety buffer requires more than 50% of the tract of land, compensation tools such as acquisition, transferable development rights, purchase of development rights, a system of variances from the technically based setback, or open space incentives may not be legally required, but should be considered (see Appendix D). There are many compensation measures available that do not involve the purchase of property.

If a safety buffer requires more than 75% of a particular tract of land, compensation should seriously be considered. All stakeholders should be involved in the decision making process including the landowner and the public. Factors that should be considered in determining the extent of the safety buffer are the government purpose; the government duty to protect the health, safety and welfare of the public; the economic impact on the landowner; the investment backed expectations of the landowner and fairness issues in general.

5.6 Down Zoning of Land

To this point, the discussion in this Chapter has concentrated on a change in district classification that increases the existing density of land use. Separate from this analysis is the issue of reducing the density of land or "down zoning," in which high density land such as urban is reclassified to a lower density use, such as conservation. While this may be a tool for hazard mitigation, it is likely to raise a regulatory takings issue and should be considered as a measure of last resort, especially if the down zoning is opposed to by the landowner.

At the State district classification stage, landowners will likely have low investment-backed expectations compared to other development stages (Figure 2-5). Nevertheless, they will have some investment-backed expectations for land that exists in the urban district.

Down zoning land which has been previously designated as urban increases the risk of a taking; however, it may still be a tool for hazard mitigation. If the government and public deem an area sufficiently important, mechanisms for compensation in the form of acquisition, land swaps, transferable development rights, and partial purchase of development rights can be employed to compensate the landowner for the down zoning. The advantage of considering down zoning is that at this particular development stage, the land is likely to be relatively inexpensive (Figure 2-5) and thus mechanisms for compensation are likely to be more effective. The agency might also choose to enter into formal negotiations with a landowner to provide a compensation package, or if the landowner is uncooperative, the agency can buy private land for public use by exercising the power of eminent domain. In some cases, the landowner may want a property to be down zoned in order to lower the tax base on the property, or as an exchange for land to be up zoned somewhere else.

Generally, if land is already classified as high density urban, it may be more appropriate to address hazard mitigation in the next lower stages in the development chain relating to general and community planning, zoning or subdivision.

Chapter 6 - General, Community and Facility Planning (Stage 2)

It is at the formal county planning process that the community has the most influence in future development decisions. With each stage of development that passes, the weight of public opinion weakens, while the interest of the landowner grows (Figure 2-5). As a result, it is a policy of the State to encourage public participation early in the development process. For example, under the Coastal Zone Management Act, it is a policy to:

> "Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life-cycle and in terms understandable to the public to facilitate public participation in the planning and review process."[62]

Prior to the amendment of any plans, the public's input regarding development and hazard mitigation should be solicited. Sometimes the community's input may be too late, e.g., not in the community or general plans stage, but during the later portion of a subdivision project. This increases the risk that the public's desires will be outweighed by the interest of the landowner. The economic interests of the landowner become more difficult to balance with objective natural resource protection and hazard mitigation for later stages of development.

6.1 Role of General, Community & Development Plans in Land Use Decisions

The goals, policies and implementation measures in general, community and development plans create a vision for future development in an area. Landowners are put on notice and are more likely to design a project that is compatible with the plans, resulting in less chance for future landowner-pubic interest conflicts. The general and community plans influence subsequent zoning and subdivision decisions since applicable land use regulations require the plans to be followed as either policy or existing regulatory authority.

County general plans and community plans are part of the Statewide Planning System.[63] These plans guide State land use districting decisions (Stage 1) since district reclassifications must be in conformance with existing plans.[64] County general plans (Stage 2) guide zoning decisions (Stage 3), since under the State enabling legislation, zoning in all counties shall be in the context of a long range comprehensive general

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[62] Haw. Rev. Stat. § 205A-2(c)(7)(C)
[63] Haw. Rev. Stat. § 226-52(a)(4)
[64] Haw. Admin. Rules § 15-15-50(c)(18)

plan.[65] Finally, all community plans, zoning ordinances, subdivision ordinances and administrative actions by county agencies shall be in conformance with the county general plan.[66]

From the above, the county general and community plans can play an important role in hazard mitigation. General plans are typically broad policy statement documents that are adopted by the individual counties. In contrast, development or community plans are more site specific and attempt to implement the policies and objectives that are found in the general plans.[67] The development and community plans are also more specific with regard to the social, economic and physical characteristics of the area that the plan covers. This is a generalization, however, since the general plan for Kauai is very detailed and provides specific direction for development in certain areas.

In creating or amending general and community plans, valuable input is received from neighborhood boards, state and county agencies, public interest groups, landowners and businesses which help to guide growth and put all interested parties on the same page as to the future development in an area. It is important that the community and neighborhood boards participate in this process, for their input will carry less weight for each subsequent development stage that a project passes through (Figure 2-5).

It is also vital that both landowners and businesses participate so that their interests are accounted for and a balance is struck between a feasible project, hazard mitigation and environmental protection. Participation by landowners is important so that they are put on early notice about what are "reasonable expectations" for development in the area. Investments made in furtherance of a project that is unreasonable for a site, or against the general or community plan may be given little weight by an approving agency or a court of law. By conforming to goals for hazard mitigation as set forth in a general or community plan, innovative design can begin early and serve to alleviate any economic impacts.

General and community plans are required to be amended on a periodic basis, typically every five to ten years. The period for update varies with each county. For Maui there is a ten year review period.[68] On Oahu, amendments to each development plan are reviewed annually and the general plan is to be reviewed every five years.[69] On Kauai, there is to be a comprehensive review of the general plan every ten years with recommended revisions as necessary.[70] For Hawaii County, the general plan is amended

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[65] Haw. Rev. Stat. § 46-4(a)
[66] Maui County Ordinance 2.80A.010. Under the Revised Ordinances of Honolulu, § 24-1.2, public facilities, zoning changes and subdivisions must be consistent with the development plan, which must be consistent with the goals and objectives of the general plan.
[67] Revised Ordinances of Honolulu § 24-1.9(a)
[68] Maui County Ordinance § 2.80A.030
[69] Revised Ordinances of Honolulu § 24-1.13(a)
[70] Kauai General Plan - p. 9-1

every ten years and new community development plans are being created for selected areas.[71] It is during the creation or amendment of plans that necessary measures for hazard mitigation can be addressed.

General, community and development plans are implemented through the comprehensive zoning ordinance for the counties. As these plans are updated, there could be a correspondent change to the zoning ordinance to insure consistency.

Community or development plans may also be amended by the State or an individual upon filing an application for amendment.[72] An amendment to community or general plans may require an environmental assessment and any other information that the agency may require.[73] For amendments that are applicable to major projects along the coast, a hazard assessment following the guidelines in Chapter 4 would be recommended so that the community plan is not changed to designate an area for high density use, if there are high risks from hazards.

General, community and development plans should include objectives, policies and implementation measures that relate to hazard mitigation. It is recommended that provisions be added if: (i) the current plans do not address the issue of hazard mitigation, or (ii) address the issue, but are too vague too provide proper direction for implementation. For example, a design standard to: "provide additional setback requirements along shorelines subject to high erosion risks" would be unsuitable if the erosion risks are not defined or not adequately compensated for. A more protective design standard would be: "provide additional setback requirements along shorelines subject to high erosion risks based on the life expectancy of structures and an erosion rate to be determined by the agency, or the applicant." Detailed measures are more helpful in hazard mitigation than broad general statements. This is especially so for provisions related to implementation.

Sample hazard mitigation objectives and policies are provided in Figure 6-1 and sample implementation measures are found in Figure 6-2. These provisions are suitable for incorporation in general plans, but can also be found in development or community plans. Some of the sample provisions are directly from the Federal Coastal Zone Management Act, Hawaii State Plan or the Hawaii CZM Act, which governs State and local agency decisions. Placing existing provisions in the general or community plans should not be controversial because many are already applicable at various stages of development. The placement of existing policies and objectives into land use plans serve to reinforce the need for hazard mitigation planning and set the stage for implementation measures that are detailed, proactive and effective. In addition, placement of federal and State policies into the plans insures consistency within the various levels of government.

[71] Interview with Norman Hayashi, Hawaii County Planning Department
[72] Maui County Ordinance § 2.80A.060(D), Revised Ordinances of Honolulu § 24-1.13
[73] Maui County Ordinance § 2.80A.060(D)(8)(h); Haw. Rev. Stat. § 343-5(a)(6)

Some of the sample provisions in Figures 6-1 and 6-2 are a slight variation of hazard mitigation measures in existing general and community plans from other counties. Progressive plans with regard to hazard mitigation are the West Maui Community Plan, the North Shore Sustainable Communities Plan for Oahu ("NSSCP") and the Kauai General Plan. These documents incorporate hazard mitigation measures to a greater extent than other plans in Hawaii, and serve as an example of what is feasible. Generally, the plans that have been updated recently are more comprehensive in addressing hazard mitigation. While improvement is being made, a general weakness continues to be that many of the implementation measures are not specifically outlined to accomplish plan goals.

The objectives and policies outlined in Figure 6-1 can be tailored to meet the needs of the individual counties. As many of the samples provided should be considered for incorporation when general and community plans are adopted or amended. There are also checklists of elements in a general plan related to hazard mitigation that can be reviewed for applicability (See Oregon Department of Land Conservation & Development, 2000).

Implementation provisions for the sample objectives and policies are found in Figure 6-2. Implementation measures can be procedures, new policies, performance standards, design criteria, ordinances or regulations. Since the philosophy of this manual is to utilize a light-handed approach for implementation (Chapter 2), new ordinances and regulations are not recommended unless existing rules are ineffective on their face, or as applied. If an existing regulation is ineffective as applied, it is preferable to change the procedure on how it is applied, rather than propose a new regulation. Thus, many of the implementation measures in Figure 6-2 are procedural in nature.

The samples in Figures 6-1 and 6-2 are provided to: (i) introduce new provisions important for hazard mitigation to be considered by the counties; (ii) show similar provisions have already been incorporated in Hawaii, thus demonstrating their feasibility; or (iii) cite provisions from state and federal laws to insure consistency at all levels of government.

The sample provision in Figure 6-2 from the West Maui Community Plan related to open space is significant in that it calls for a study to determine a coastal erosion rate, and then a planning period of 50 to 100 years to determine a safety buffer. This is comparable to the recommendations in this manual related to the determination of the erosion zone (Chapter 4).

The North Shore Sustainable Community Plan, which is referenced numerous times in Figure 6-2, states that implementation could be more challenging for the agencies because of the wider guidance provided for decisions related to land use, public facilities, and infrastructure, as well as for zoning matters. This contrasts to previous development plans, which functioned primarily as regulatory guides and a prerequisite for City zoning of parcels proposed for development.[74]

This manual also provides a wide range of guidance in that hazard mitigation is recommended at all stages of development, including zoning. While wide ranging guidance may be viewed as a challenge, it should actually enhance decision making and hazard mitigation. First, it can lead to consistent policy for all stages of development. This will allow a landowner to rely on decisions from an agency and plan accordingly. Also by coordination with agencies, redundant review and analysis can be avoided. A landowner should only have to determine the erosion zone or assess hazards one time. This should be as early as possible in the development process. Once the assessment is conducted, it need not be done for subsequent development stages.

Development and community plans are an important tool for hazard mitigation because they can provide site specific guidance that certain areas should remain undeveloped or be developed in a certain manner. As an example, for Kauai, the Koloa-Poipu-Kalaheo Development Plan states that development towards Mahaulepu (Figure 6-3) beyond the existing State urban district should not occur and coastal lands particularly should remain undeveloped.

Other plans may call for a specific area to be: (i) developed as a cluster subdivision, (ii) designed as a planned unit development, (iii) maintained as rural or agricultural character with low density use,[75] or (iv) acquired from the landowner.[76]

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[74] North Shore Sustainable Communities Plan – Chapter 5

[75] North Shore Sustainable Communities Plan – Chapter 1

[76] The Koloa-Poipu-Kalaheo Development Plan calls for the acquisition of properties makai of Poipu Beach Road. The Hawaii County General Plan encourages acquisition of shoreline areas in North Kona (p. 38).

Hazard Mitigation Objectives

- Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, volcanic eruptions, and other natural or man-induced hazards and disasters (Hawaii State Plan - HRS § 226-12(b)(5)).
- Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence and pollution (Hawaii CZM Act - HRS § 205A-2(b)(6)(A)).
- Design new developments suitable and appropriate for their location (Hon. Gen. Plan – Chapter VII).

Hazard Mitigation Policies

- Tailor hazard mitigation measures with the specific stage of development to account for different agencies, laws, policies, rights and resources of the regulated party and the role of the community.
- Assess the risk from all natural hazards as early as possible in the development process.
- Manage coastal development, "to minimize the loss of life and property caused by improper development in flood-prone areas, storm surge, geologic hazard, and erosion prone areas and in areas affected by or vulnerable to sea-level rise, land subsidence, and saltwater intrusion, and by the destruction of natural protective features such as beaches, dunes, wetlands and barrier islands" (Federal CZM Act – 16 U.S.C.A. § 1452).
- Require development projects to give due consideration to features such as slope, flood, and erosion hazards (Honolulu General Plan – Chap. III).
- Control development in areas subject to storm waves, tsunami, flood, erosion, and subsidence (HI CZM Act - HRS § 205A-2(c)(6)(B); Kauai Gen. Plan – p. 7-23).
- In new resort developments and subdivisions along the coast, buildings are setback from the shoreline in order to. . . avoid potential tsunami or hurricane damage; to preserve dunes, coastal bluffs, and other important physical features; to allow space for coastal erosion. . . Setbacks are based on historic coastal erosion trends, damages during past hurricane and tsunami events, the nature of the topography and scenic values. (Kauai General Plan – p. 2-12).
- Setback residential and resort development beyond the historic hurricane inundation zone and beyond areas at hazard of chronic beach erosion (Kauai General Plan – p. 2-12).
- Implement land use zoning to restrict future development within identified floodway, flood fringe, coastal high hazard, and general flood plain districts *(NSSCP – Chapter 4, Section 4.6.1 – this is equivalent to the erosion, wave (V-VE) and flood (A-AE-X) zones in this manual).*
- Maintain open, preservation and other low density zones in areas subject to erosion, wave, flood and other hazard risks (See Kauai General Plan 3-14).
- Require developments in flood and tsunami areas to be located and constructed in a manner that will not create a health or safety hazard (Honolulu General Plan – Chapter VIII).
- In areas vulnerable to severe damage due to the impact of wave action, restrictive land use and building structure regulations must be enacted relative to the potential for loss of life and property (Hawaii County General Plan – Section 4(D)).
- Control development of critical facilities and their infrastructure in the erosion, wave (V-VE) and flood A-AE-X) zones.
- Plan subdivision layout early in the permitting process and use creative and flexible design to mitigate the risks from coastal hazards while minimizing economic impact (see Kauai General Plan – p. 5-9).
- Encourage proactive planning and input from all parties regarding hazard mitigation and new coastal development for amendments to the general, community and development plans.
- Coordinate hazard mitigation among federal, state and local agencies to eliminate redundant review and insure consistent policy.

Figure 6-1 – Sample Hazard Mitigation Objectives & Policies for County General Plans

Hazard Mitigation Implementation Measures

Hazard Assessment

- The State, the local agency, or if the data is not available, the applicant of the coastal development should assess all potential hazards for land use district reclassifications (Stage 1), major community & development plan amendments (Stage 2), zoning changes (Stage 3) and subdivision approvals (Stage 4). The erosion, wave (V-VE), flood (A-AE-X) and inland zone should be determined. The Assessment should utilize the most recent studies & updated data bases.
- Determine the erosion zone for development of infill lots along sandy shorelines (Stage 7).
- The erosion zone should be based on a safety design buffer, a storm erosion event, the life expectancy of proposed structures, and an erosion rate adjusted for errors and sea-level rise.
- Reports such as the FEMA CCM (FEMA, 2000), Atlas of Natural Hazards in the Hawaiian Coastal Zone (Fletcher, et al., 2002), Principles in Planning and Designing for Tsunamis (National Tsunami Hazard Mitigation Program, 2002), this manual or other reports should be referenced in the Plans to provide: (i) background on the various coastal hazards, (ii) measures to reduce risks, (iii) an explanation on the benefits of hazard mitigation and (iv) notice to the homeowner of potential development concerns and applicable design standards.

District Reclassification, Zoning, Subdivisions

- Protect the shoreline and beaches by preserving waterfront land as open space wherever possible. This protection should be based on a study and analysis of the rate of shoreline retreat plus a coastal hazard buffer zone. Where new major waterfront structures or developments are to be approved, preservation should be assured for 70 -100 years by employing a shoreline setback based on the rate established by the appropriate study. *(The West Maui Community Plan has similar language, with a time frame of 50-100 years) — the Honolulu Revised Ordinances § 24-1.4 allows for additional setback requirements exceeding the minimum permitted under zoning to account for high erosion risks).*
- Through land use district reclassification, general & community planning, zoning and subdivision, prohibit new development in erosion zones – analyze in the hazard assessment avoidance in the wave and flood zones. Prohibit critical facilities in erosion, wave & flood zones *(see NSSCP – Chapter 4, § 4.6.1 for similar provision related to zoning).*
- The subdivision applicant should meet with the agency **before** the preliminary plat is worked on to review hazard mitigation issues. Creative designs such as cluster subdivisions, planned unit developments, planned developments and other innovative layouts with a mix of lot sizes and geometry should be required *(see Chapter 8)*. This will allow the safety buffer to be maximized while providing economically beneficial use of the land.
- Where structures are permitted on lands abutting the shoreline, adequate setbacks should be provided. Establish greater shoreline setbacks for new structures in erosion hazard areas, using criteria from the various shoreline studies. New structures should incorporate building styles compatible with coastal hazards such as coastal erosion, tsunami and hurricane overwash *(NSSCP – Chapter 3, § 3.1.3.2.).*

Infrastructure Improvement

- Preserve, protect and/or nourish the shoreline sand dune formations throughout the planning region. These topographic features are essential to beach preservation as well as hazard mitigation and are a significant element of the natural setting that should be protected *(The West Maui Community Plan has similar language, except the reference to hazard mitigation is added in this proposed provision).*

General

- Recommend approval, approval with modification, or denial of developments seeking zoning and other development approvals based on how well they support the policies, objectives and implementation measures related to hazard mitigation *(See NSSCP – Chapter 5 for similar provision).*

Figure 6-2 – Sample Implementation Measures for Hazard Mitigation Appropriate for County General Plans or Community and Development Plans.

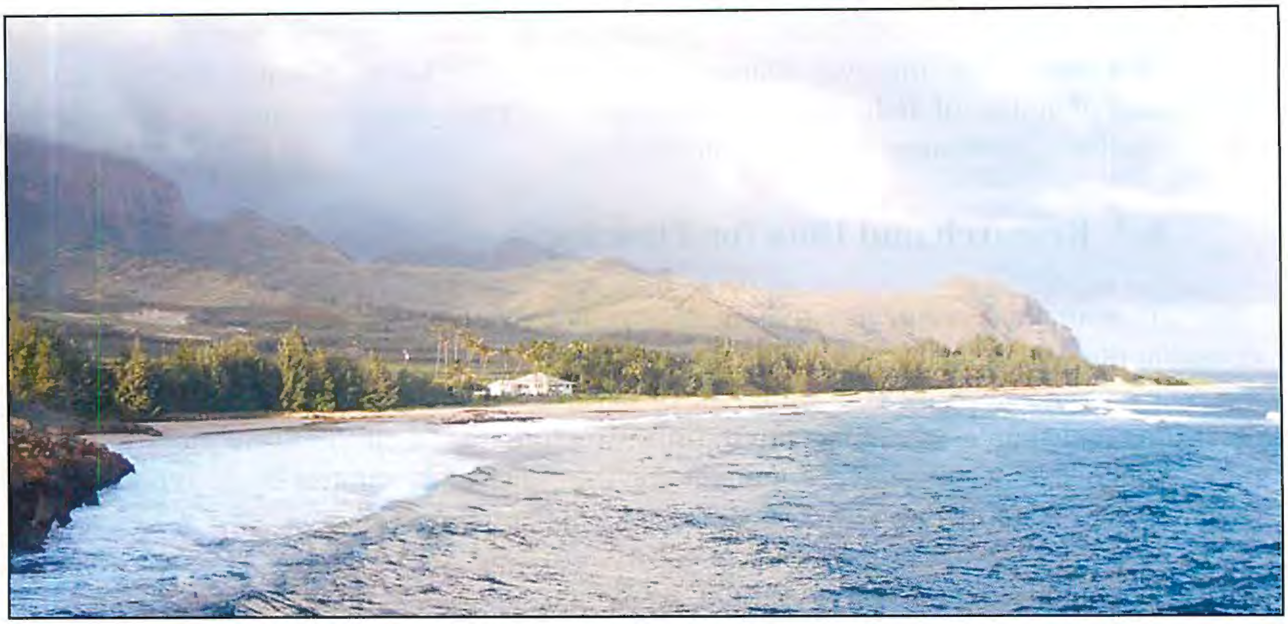

Figure 6-3 – Mahaulepu Beach, Kauai – The development plan for this stretch of coast calls for the area to be protected from further development in order to maintain the unique environmental character. Such provisions can also be utilized to implement hazard mitigation measures for high risk areas.

6.2 Functional and Facility Plans

As with the formation of community and development plans, functional and facility plans should actively involve many parties, including the neighborhood boards, community organizations, businesses, landowners, and special interest groups.

Functional and facility plans can guide the public investment in infrastructure. Development in areas of high hazard risk can be discouraged by diverting the development of infrastructure away from the area. This would require data suitable for planning on coastal hazards as well as identification of the hazard issue early on during the creation or amendment of functional and facility plans.

The functional and facility plans may have important design criteria, e.g., the location of future roads. Road location can play an important role in hazard mitigation, especially if habitable structures will be placed between the coastline and the road (Chapter 8). Placement of roads too close to the coastline may leave the developer or architect with poor siting options to mitigate hazard risks. Before roads are sited and designed, a hazard assessment with erosion study would be recommended.

Kauai's policy in roadway design promotes setbacks, landscaping and scenic views where a scenic roadway corridor is designated within a town, or adjoins an area for urban use.[77] The State DOT can use policies in the Kauai general plan as part of the criteria for long-range highway planning and design.[78] Hawaii County has a policy to coordinate planning of federal, State and county street systems to meet program goals such as historic, recreational quality, and land use.[79]

6.3 Research and Data for Planning

This manual advocates that if data is not available, a project applicant hire a consultant to assess the local hazard risks for the particular project. By analogy, the State or county would need to assess the risk of hazards for their own projects. The need to determine safe areas to concentrate infrastructure, as well as to correctly design improvements is a persuasive argument for the State and counties to actively support research and data collection of coastal hazards on a large scale.

Comprehensive research should be conducted on shoreline erosion statewide, similar to the study that was conducted for Maui County by the University of Hawaii School of Ocean Earth Science & Technology (Figure 4-2). In the future, flood maps may be refined using hurricane modeling or by utilizing laser technology to more accurately map the coastal topography and runup areas. This data is needed for decisions that the State or county will need to make regarding the placement of their own infrastructure.

[77] Kauai General Plan – p. 5-21
[78] Kauai Long-Range Transportation Plan prepared by State DOT and the Kauai County Planning Department – Kauai General Plan – p. 7-7
[79] Hawaii County General Plan – Section 4(L)

Chapter 7 - County Zoning (Stage 3)

County zoning is placed as Stage 3 in the development hierarchy because changes in current zoning must be consistent with county general, development or community plans. Therefore, zoning generally follows the planning process, even though there may be amendments to the plans that occur after zoning for an area is established.

Every county has land use zones that may be designated for various purposes, such as residential, apartment, resort, hotel, commercial, and industrial uses as well as lower density zones such as open, parks, recreation and preservation.

On Oahu, the preservation boundary is for lands: (i) having an elevation below the maximum inland line of wave action; and (ii) areas susceptible to floods and soil erosion, lands undergoing major erosion damage and requiring corrective action by the state or federal government, and lands necessary for the protection of the health, safety and welfare of the public by reason of soil instability or the lands' susceptibility to landslides and/or inundation by tsunamis and flooding.[80] Preservation areas encompass elements of Oahu's natural environment and support the health, safety and welfare of the public. Therefore, these areas are to be protected from incompatible development.[81] Preservation boundaries are for areas unsuitable for other uses because of topographical considerations related to public health, safety and welfare.[82]

For Kauai, the open designation is to preserve, maintain or improve the natural characteristics of land and is for areas susceptible to flood, hurricane, tsunami, coastal erosion, landslide or subsidence. Open zones shall be free of development involving buildings, paving and other construction.

Hawaii County also has an open district for areas that contribute to the general welfare, the full enjoyment, or the economic well-being of open land use which has been established, or is proposed.[83] The open district may also be to protect investments which have been or shall be made in reliance upon retention of open space or to buffer an otherwise incompatible land use or district. This may be the case if an area proposed for development is in a high risk hazard zone and the issue cannot be addressed through proper construction techniques. Uses in the open district may include parks, recreational areas and golf courses.[84]

In August of 2003, Maui County officially adopted two categories of open space

[80] Revised Ordinances of Honolulu § 24-1.3(k); North Shore Sustainable Communities Plan – Chapter 2, § 2.2.1
[81] Revised Ordinances of Honolulu § 24-1.5(b)
[82] Honolulu Land Use Ordinance Article 3 § 3.40(e)
[83] Hawaii County Code § 25-5-160
[84] Hawaii County Code § 25-5-162

districts to distinguish between passive and active types of land use. OS-1 (Passive) is for sensitive ecological areas, such as for wetlands or threatened and endangered species. OS-2 (Active) is for, among other things, drainage ways, hazardous areas, or as a buffer for sensitive ecological areas. For both zones, dwellings are prohibited and structures area to be sited and constructed in a manner to avoid flooding and other natural hazards.[85]

Maui also has an open space initiative in which there is a bonus in floor area and building heights for keeping seaward areas as open space.[86] These incentives are applicable to apartments, hotels and business areas.[87] A similar scheme can be worked out for residential areas. The other counties should explore Maui's open space incentive because it provides inducement to keep spaces open, which reduces the risk from coastal hazards. Furthermore, the scheme is a form of compensation which can ease the economic burden on the landowner and help to address any legitimate regulatory takings issue.

7.1 Hazard Mitigation in the County Zoning Process

It is recommended that hazard mitigation be addressed during the county zoning process. The decision-making process is similar to that discussed in Chapter 5 for State district reclassifications (compare Figures 5-1 and 7-1). The trigger to address hazard mitigation would occur when there is an amendment to change county zoning for a coastal property from a low density use to a higher density use.

Key in the decision-making process is having the information for planning. This would require a hazard assessment as reviewed in Chapters 3 and 4 of this manual (top of Figure 7-1). The authority for the counties to request a hazard assessment is fourfold. First, the counties may have in their zoning codes, specific provisions that request a county environmental report for a zoning amendment.[88] These reports usually ask for a description of the physical, social and natural resource consequences of a proposed action.[89] Second, the zoning codes require consistency with the general plans and community plans.[90] These plans usually have objectives, policies and measures for hazard mitigation (see Chapter 6). Third, the county zoning code may impose criteria for zone change that there are no circumstances that would be adverse to the public health,

[85] Maui Comprehensive Zoning Ordinance §§ 19.07.020, 19.07.050, 19.07.060
[86] Maui Comprehensive Zoning Ordinance § 19.56.010
[87] Maui Comprehensive Zoning Ordinance § 19.56.020
[88] Hawaii County Code § 25-2-42. For Honolulu, however, the assessment may only be required for significant zone changes greater than 10 acres (see e.g., Revised Ordinances of Honolulu Chapter 24 § 24-8.7 and other community plans). For Kauai, an SMA permit with associated environmental review is not required for amendments to the County general plan, development plans, State land use district boundaries and zoning changes (Kauai SMA Regulations - Section 3).
[89] Hawaii County Code § 25-1-5
[90] Hawaii County Code § 25-2-40; Maui Comprehensive Zoning Ordinance § 19.04.015(B)(1) and § 19.510.040(A)(4(a)

safety or welfare.[91] Whether these circumstances are present would require a hazard assessment. Fourth, almost all land use rules have provisions that allow the agency to ask for more information regarding the project and its impacts.[92]

While the request for a hazard assessment is within the counties' power, it could arguably be described as discretionary. Nevertheless, hazard mitigation should not be ignored by the landowner/developer otherwise it will likely need to be addressed by the future homeowner when the stakes, as well as the financial and emotional burden are greater (Section 1.2.4). Furthermore, the ability of the government to mitigate for coastal hazards will diminish with each stage that the project passes through.

The hazard assessment would not be needed if it was completed during an earlier stage of development (Stages 1 or 2 in the development process). Once the hazard assessment is completed, it should satisfy informational needs for all subsequent development stages.

With the completed hazard assessment, the erosion, wave (V-VE), flood (A-AE-X) and inland zones can be superimposed on a map of the property being considered for a zone change. Using guidance in other reports or this manual, the counties could decide how they wish to proceed with the zone change.

Figure 7-1 is a decision tree for a hypothetical change that starts at a low density zone (open or preservation) and seeks to convert to medium density (agricultural or rural) or a high density (residential and resort) zone. For a small lot and a large erosion or hazard zone (lower left portion of Figure 7-1), keeping the area in open or preservation zones would provide the greatest protection.[93]

For a medium size erosion or hazard zone (lower middle portion of Figure 7-1), there are three possibilities. First, hazard mitigation may be provided by changing to a medium density use, but not the highest density. This, however, may still result in development in erosion or hazard areas. A more suitable alternative is to partition the property with the erosion or hazard zone to stay in low density use while changing the areas outside to higher density. Another alternative is to change to a high density use but provide conditions for a safety buffer that run with the land.

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[91] Hawaii County Code § 25-2-44; Maui Comprehensive Zoning Ordinance § 19.04.015(B)

[92] Hawaii County Code § 25-2-42(a)(6); Maui Comprehensive Zoning Ordinance § 19.510.010(D)(25)

[93] As discussed in Chapter 5, the hazard zone is determined by how protective the county wishes to be in siting development in coastal areas. The hazard zone could include the erosion zone, both the erosion and wave zone, or the erosion, wave and flood zones (Figure 3-1). It is anticipated that in most cases, the hazard zone will coincide with the erosion zone.

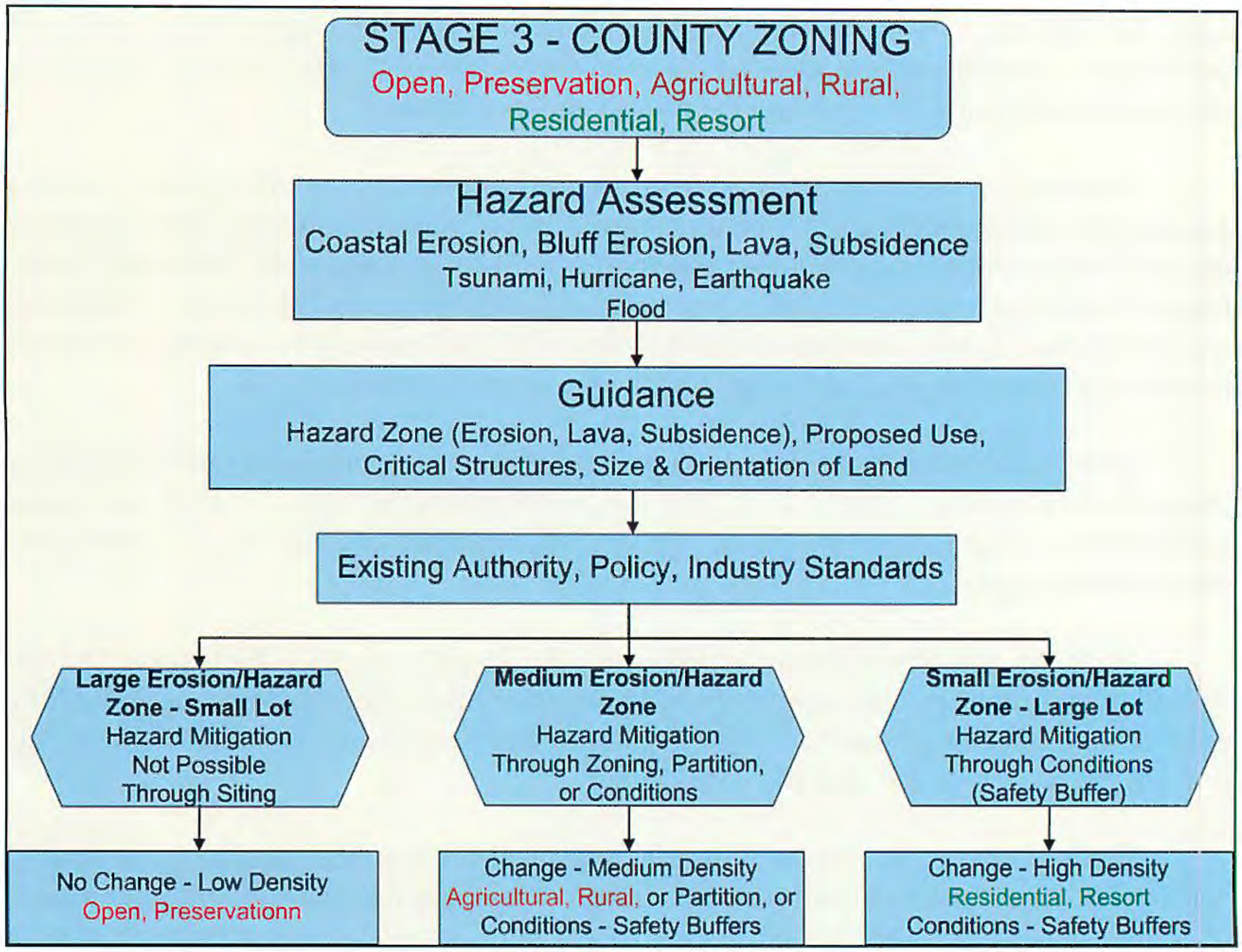

Figure 7-1 – Local Zoning Decision Tree - The decision to change zoning at the county level is similar to that at the State land-use reclassification stage (Figure 5-1), except the zones are different. At the local level, open and preservation zones are for low density use. Agriculture and rural areas are for medium density use, while high density use may require a change in zoning to residential or resort.

For large lots and a small erosion or hazard zone (lower right corner of Figure 7-1), conditions for a safety buffer that run with the land are the recommended alternative.

In the scenario where the land is already in medium density use (agriculture or rural) and the applicant seeks to convert to high density use (residential or resort) in a hazard zone, there are three alternatives: (i) no change in zoning, (ii) partition with the erosion or hazard zone to remain medium density use while the areas inland are changed to a higher density use, or (iii) change to a higher density with conditions for a safety buffer encompassing the erosion or hazard zone that run with the land. Because medium density zones such as agricultural or rural may not be sufficiently protective to reduce the risks from coastal hazards, the preferred alternative is to approve to a higher density use coupled with a sufficient safety buffer as a condition that runs with the land.

In Chapter 5, Figures 5-2 through 5-5 were presented for different State land use district reclassification scenarios. These figures are for situations in which lots have different size, orientation, erosion rates, and proposed uses. These scenarios are also relevant for zoning changes at the county level. The key factor in assessing the zone change is what percent of the lot is in the erosion, wave (V-VE) or flood (A-AE-X) zone.

Given the large size of lots that are usually along the coast before land is zoned and subdivided, it is likely that the majority of situations can be addressed with conditions for a safety buffer. Generally, county councils can place conditions on a parcel of land during a zoning change.[94] Such conditions can be made to run with the land.[95] Thus, hazard mitigation measures that call for correct siting can propagate down the development chain.

As in Stage 1 (Chapter 5), similar ratios are recommended for when compensation may be appropriate.[96] If a hazard zone consumes more than 50% of the tract of land, compensation while not legally required, should be considered. If the amount is 75% or more, compensation tools such as acquisition, eminent domain, transferable development rights, partial purchase of development rights, lease purchase, open space incentives, a system of variances or other measures should be seriously considered. Many of these alternatives do not require the expenditure of public funds. In determining the impact of a safety buffer, consideration should also be given to flexible subdivision and site design to mitigate impact on the landowner (see Sections 7.1.1, 8.9 & 8.10).

7.1.1 Planned Unit Developments, Cluster Developments, Project Districts, Planned Developments

Planned unit developments ("PUD"), cluster developments, project districts and planned developments are methods to provide for creative and flexible design, which will allow a development project to conform with the given topography and natural features of the area. These development tools are covered in Chapter 8 on subdivisions, but are mentioned in this Chapter because some counties require the area to be specifically zoned for clusters, PUDs, project or planned developments.

The utility of these zoning mechanisms will not be known until a hazard assessment is conducted and the extent of the erosion or hazard zone is determined relative to the project site. This is one more reason that the hazard assessment should be done as early as possible (i.e. at the zoning vs. the subdivision stage).

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[94] Hawaii County Code § 25-2-44

[95] Hawaii County Code § 25-2-10

[96] Compensation as used in this manual is not restricted to only measures that call for the payment for the purchase of property. More palatable measures, from an agencies perspective, may include a system of variances, or a relaxation of standards related to esthetics (e.g., floor area, height limitations, side and front setbacks) to compensate for implementation of a technically based shoreline setback.

In Maui's Lanai Project District for Manele, general standards in the comprehensive zoning ordinance require a setback of 300 feet from any beach and provide that 95% of all dune areas should remain as open space.[97] These zoning requirements illustrate that if an issue is addressed early enough, open space for hazard mitigation or environmental protection can be properly maintained. These requirements would then control subsequent development stages such as the layout of lots during subdivision (Stage 4) or the grading of the area during infrastructure improvements (Stage 5).

7.1.2 Hotels and Resorts

Hotels and resorts require specific zoning to be developed. There are many potential provisions in zoning codes for hotels and resorts that can be applied to the mitigation of hazards. Maui and Oahu have open space incentives or bonuses in which extra floor area can be added in the form of increased height or variances from yard restrictions in return for providing more open space.[98] This open space can be concentrated along the coast to provide the needed safety buffer for erosion or other hazards, while at the same time, preserving the environment and scenic vistas.

Such a scheme of open space incentives provides compensation to the landowner and should be considered for developments other than hotels and resorts.

7.2 Down Zoning at the County Level

The analysis in this Chapter relates to any zoning change along the coast that increases the density of land use. The issue of down zoning, in which zoning changes decrease the density of land use was discussed in Chapter 5. Generally down zoning of land should not occur against the wishes of the landowner. There may be an instance in which a landowner does want the area down zoned, (e.g., the area is unusable and down zoning will lead to a lower tax basis for the property). In the implementation of Maui County's new Open Districts, landowners have actually proposed to have their property down zoned in exchange to have other areas up zoned.[99]

If it is opposed by the landowner, down zoning is likely to raise a regulatory takings issue (see Appendix D). If an area needs to be protected and has already been zoned for high density use, hazard mitigation can be provided by using compensation tools or addressing the problem at the next lower stage in the development hierarchy (Figure 2-2).

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[97] Maui Comprehensive Zoning Ordinance § 19.70.100(A) and (B)(10)
[98] Maui Comprehensive Zoning Ordinance § 19.56.010; Honolulu Land Use Ordinance – Article 9 § 21-9.80-7
[99] Interview with John Summers – Maui County Planning

Chapter 8 - Subdivision of Land (Stage 4)

From a purely physical standpoint, most siting issues for hazard mitigation could be addressed during the subdivision stage. However, because of investment-backed expectations and vested rights of the landowner, as well as political pressures during the subdivision process, siting issues should ideally be addressed much earlier (Stages 1-3).

A subdivision is defined broadly and occurs when a landowner takes a large parcel of land and divides it into smaller lots by a traditional subdivision, cluster development, or a planned unit development. In the past, there has been a tendency to group the landowner and future lot buyer/homeowner together in hazard mitigation strategies. This is a mistake since these are two distinct parties with different interests, rights and duties.

The landowner's motive for development is to produce a product (lots with certain size, location, geometry and infrastructure improvements) that provides a sufficient return on capital. The homeowner, on the other hand, is a buyer of the product. If a coastal area needs a large safety buffer, but small lots are created, then the product may be poorly designed and expose the occupants to unnecessary hazard risks when houses are built on the substandard lot. Since there is a buyer-seller relationship, consumer protection laws come into play (Chapter 10).

Since the producer of a product is in better position to address a design issue than the buyer, it is recommended that government agencies require proper safety features in coastal lots to protect: (i) the consumer; (ii) the future occupants; and (iii) the environment from the creation of lots with an insufficient safety buffer. With early consideration of coastal hazards, it is possible to protect inhabitants and provide economic return through creative subdivision design that employs many of the land use measures described in this Chapter.

8.1 Duty of Agencies to Insure Subdivisions Suitable for Intended Use

The counties have a greater authority and duty than is generally believed, or has historically been exercised, to control the design of subdivisions along the shore. This duty stems from provisions to protect the public natural resources, and more importantly the future occupants of a development project who will not be in a position to protect themselves. Every county has subdivision regulations which require the subdivision to be suitable for its intended use. For example:

> "No subdivision shall be granted tentative approval of the preliminary map or approval of the final map if the land is found by the Director, upon consultation with the Chief Engineer or other government agencies to be

unsuitable for the proposed use by reason of proneness to flooding, bad drainage, geologic conditions, unstable surface, ground water or seepage conditions, inundation or erosion by sea water, proneness to slides or similar hazards . . . or other features or conditions likely to be harmful or dangerous to the health, safety or welfare of future residents of the proposed subdivision."[100]

"All lots shall be suitable for the purposes for which they are intended to be sold and no dangerous areas subject to periodic inundation, in such a manner as to endanger the health or safety of the occupants thereof, may be subdivided for residential purposes."[101]

Subdivisions shall be planned, designed and constructed to avoid the possibilities of erosion. . . .[102]

"A lot shall be suitable for the purposes for which it is intended to be sold. No area subject to periodic inundation which endangers the health or safety of its occupants may be subdivided for residential purposes."[103]

"The lot size, width, shape and orientation, and the minimum building setback lines shall be appropriate for the location of the subdivision, the type of development and uses contemplated. . ."[104]

The above provisions require the agencies to make sure a subdivision design will not result in undue risks to future residents. Some of the provisions identify a range of coastal hazards, while others only mention erosion or wave inundation. As shown in Figures 1-9 and 3-1, coastal erosion, flooding and wave inundation are related. Planning for erosion will mitigate the impacts of flooding and inundation, while not planning for erosion will increase the risk that a future inhabitant will be threatened.

To determine if a subdivision is suitable for its intended use, some key questions for coastal residential projects are: What is the life expectancy of the structure? What is the erosion rate? What other hazards are likely in the area? As discussed in Chapter 4, well-designed wood frame residences should be expected to have an average life of 70 years. If a house is placed 40 to 60 feet away from a shoreline eroding one foot per year, then significant erosion, flooding and inundation problems would be expected.

Whether a subdivision design along the coast is suitable for its intended use can

[100] City and County of Honolulu – Planning Commission – Subdivision Rules and Regulations § 4-403
[101] Maui County Subdivision Ordinance - § 18.16.240
[102] Kauai County Code § 9-2.2
[103] Hawaii County Code § 23-37
[104] Hawaii County Code § 23-32. A similar provision is in Maui Subdivision Ordinance § 18.16.220.

only be determined if a current hazard assessment with erosion analysis is conducted before the design of the subdivision begins. This will ensure that the assessment results are not based on the subdivision design, but that the subdivision design is based on the assessment. Figure 4-5 illustrates a recommended assessment standard.

8.2 Preliminary Plat Versus Final Plan

There is usually a two-step process for subdivision approval.[105] First, a preliminary plat is submitted to the agencies with the initial design proposed by the landowner.[106] Information on the layout of streets and the approximate location and size of lots must be provided. This information is reviewed by the agencies and a preliminary approval may be given for the conceptual design.

Based on the preliminary approval, the landowner must then work to finalize the final plat for review and approval. Surveys would be required to finalize the drawings and much additional information would be required, such as the submission of construction and grading plans.[107]

In order to create the preliminary plat or the final plat, the landowner may spend considerable time and money on consultants to do the necessary design, layout, engineering, survey and research. As early as possible in the subdivision process, it is important to inform the subdivider that hazard mitigation may require siting considerations that affect the layout of the subdivision. Early notice will insure that considerable resources are not spent to create a preliminary subdivision map that has not addressed hazard mitigation and siting issues.

The notice to address hazard mitigation may come from the general, community or development plans, if they are drafted correctly (Stage 2 – Chapter 6). It may also come from the district reclassification (Stage 1 – Chapter 5) or zoning stages (Stage 3 – Chapter 7), if the specific project has gone through these approvals prior to subdivision and a request was made to conduct a hazard assessment. If the notice in these prior stages is inadequate, it is recommended that the notice be given at the subdivision stage, before design of the preliminary plat.

8.3 Initial Consultation

Almost all subdivision regulations allow the subdivider to contact the planning department's office for information regarding procedures and general information that may have a direct influence on the proposed subdivision.[108]

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[105] Hawaii County Code § 23-12, Kauai County Code §§ 9-3.2 & 9-3.5, Revised Ordinances of Honolulu § 22-3.6.
[106] Hawaii County Code § 23-58, Kauai County Code §§ 9-3.2, Maui Subdivision Ordinance § 18.08.020
[107] Kauai County Code § 9-3.5
[108] Hawaii County Code § 23-57, Maui Subdivision Ordinance § 18.08.020

This initial consultation should be strongly encouraged so that the issue of hazard mitigation can be discussed with the agency before work on the preliminary plat is started. The initial consultation would provide early notice to the project proponent on the need to incorporate hazard mitigation into the project, insure the safety of future occupants and most importantly, utilize creative design that allows technically-based setbacks while minimizing economic impact. This initial consultation would be even more important if hazard mitigation for the project was not assessed in an earlier stage of development.

8.4 Hazard Assessment in the Subdivision Process

Subdivisions normally must meet certain requirements such as:

1. Conformance with the objectives and policies in general, community and development plans.[109] These plans should have objectives, policies and implementation measures related to hazard mitigation (Figures 6-1 and 6-2).

2. Consistency with the objectives and policies in the Coastal Zone Management Act related to hazard mitigation.[110]

3. Validation that the project is suitable for its intended use.[111]

A site-specific hazard assessment would help to determine if the subdivision project complies with the above-listed requirements. It is within the agency's discretion to request an assessment, since subdivision regulations typically provide that the agency may ask for more information regarding the project.[112]

8.5 Relationship of Hazard Assessment with SMA Permit and Environmental Assessment

In the development hierarchy, a subdivision (Stage 4) is usually the first trigger that requires a Special Management Area Use Permit and an assessment of environmental impacts (Table 8-1).[113] Prior to the subdivision, many development decisions can be made without benefit of an environmental or hazard assessment if the agencies are not

[109] Hawaii County Code §§ 23-6, 23-23, Maui Subdivision Ordinance § 18.04.030, Revised Ordinances of Honolulu § 22-3.4(b)
[110] SMA Rules - Maui Planning Commission § 12-202-10(a)
[111] See Section 8.1. The lot size, width, shape and orientation and minimum building setback lines shall be appropriate for the location of the subdivision - Hawaii County Code § 23-32.
[112] SMA Rules - Maui Planning Commission § 12-202-12(c)(2)(K)
[113] Haw. Rev. Stat. § 205A-22 provides that development for the purpose of an SMA permit includes changes in the intensity or density of land use. This could include a zone change. From a practical point of view, the counties are unlikely to request an SMA simply for a zone change, unless there is simultaneous processing for a subdivision, project or concept plan.

proactive in requesting this information under lesser known but still relevant provisions.

An environmental assessment required under a county rule may have different standards of analysis than an environmental assessment under the State's Environmental Impact Statement Law.[114] Whether it is required under State or county law, it is recommended that the assessment address hazard mitigation issues. If the project is on the coast, the guidelines in Figures 4-4 and 4-5 should be considered for evaluation.

Stage of Development	Special Management Area Permit HRS § 205A	Hawaii EA/EIS HRS § 343	Other Applicable Requirements in Agency Rules	Potential Gaps in Hazard Assessment
1 – State District Classification	No HRS § 205A-29	Yes for reclassification or use of conservation districts. No for agricultural, rural changes to urban.	LUC rules require assessment; Maui – no assessment	County reclassification of State districts (land < 15 acres). Standards for hazard mitigation analysis
2 – General, Community, Development Plans	No HRS § 205A- 29	Yes, when an individual changes zones other than to agriculture, conservation or preservation. No for county proposed changes that go through comprehensive review process.	Maui – yes for individual amending, no for county amending.	Actions proposed by county that go through review process. Standards for hazard mitigation analysis
3 – County Zoning	No HRS § 205A-29	No	Honolulu exempts for < 10 acres	Small zoning changes (less than 10 acres), Standards for hazard mitigation analysis
4 – Subdivision	Yes	No		Standards for hazard mitigation analysis
5 – Infrastructure Improvement	Yes	No		Standards for hazard mitigation analysis
6 – Lot Transfer	No	No		
7 – Home Construction	Yes – county discretion	No		Standards for hazard mitigation analysis
8 – Erosion/Hazard Noticed – Remedial Action Analyzed	Yes	Yes for use within the shoreline setback area.		Standards for hazard mitigation analysis

Table 8-1 – Environmental Assessment Requirements for Various Stages of Development - Regulatory requirements at State and county level as to when an environmental assessment is required versus the different development stages. The environmental assessment can be used as a justification for the hazard assessment but is not the only justification for a hazard assessment.

[114] Haw. Rev. Stat. § 343

To obtain an SMA permit usually requires an environmental assessment.[115] A factor to consider in the approval and thus, in the assessment, is the effect on environmentally sensitive areas, such as flood plain, shoreline, tsunami zone, erosion prone and geologically hazardous land.[116]

The hazard assessment could be either: (i) covered in the environmental assessment or (ii) separate from the environmental assessment. The advantage of the former is that it combines both environmental and hazard issues in one document and is therefore, more streamlined. A drawback is that the environmental issues are typically addressed later in the subdivision process, while information from the hazard assessment is needed for siting purposes, before work on the preliminary plat even begins.

Subdivision regulations typically require that the preliminary plat has the approximate location of areas subject to inundation or storm water overflow.[117] Kauai County requests that areas of flood and tsunami hazards, flood fringe, floodways, general flood plains, coastal high hazard and base flood elevations be shown on the preliminary map. In this manual, it is recommended that similar zones in the form of the wave (V-VE), flood (A-AE-X) and inland zone be put on the preliminary map along with the base flood elevations and the erosion zone. As will be discussed later in this Chapter, the identification of the erosion, wave (V-VE), flood (A-AE-X) and inland zones is needed to design the subdivision so that risks are reduced for occupants.

Identification of the erosion zone will help to adequately define the flooding risks, since erosion may cause the high velocity flood zone to migrate inland (Figure 1-9 & Section 4.4). As the shoreline migrates inland, flood risks may increase and expose residents near the shoreline to higher flood levels. According to Hawaii County, "it is the duty of the County of Hawaii to help protect its citizens from flooding. The need is so compelling and the implications of insuring a structure built below flood level are so serious that variances from the flood elevation or from other requirements [of the chapter on Flood Control] are rare."[118]

It is recommended that the hazard assessment be conducted early, before design of the preliminary plat begins. The hazard assessment can later be incorporated into the environmental assessment. This will ensure that necessary siting issues can be addressed in the preliminary plat stage versus at the time of the environmental assessment review, when a developer may have already spent a year or two in design and research for the project.

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[115] SMA Rules - Maui Planning Commission § 12-202-12(a)

[116] SMA Rules - Maui Planning Commission § 12-202-12(e)(2)(J)

[117] Hawaii County Code § 23-64(4), Kauai County Code § 9-3.3(a)(16), Maui Subdivision Ordinance § 18.08.060(C), Subdivision Rules and Regulations of the City and County of Honolulu § 2-201(c)(7)

[118] Hawaii County Code § 27-27.

8.6 Grading and Infrastructure Improvements

Grading and infrastructure improvements are covered in Chapter 9 of this manual (Stage 5 – Infrastructure Improvements). The counties may cover infrastructure improvements in the subdivision regulations. For example, Maui's subdivision regulations have design standards for the grading of streets, public rights of way for shoreline properties and utilities.[119] Nevertheless, the subdivision approval process and the infrastructure improvement process (Stage 5) are separate and distinct stages with the later being marked by the submission of construction plans.

8.7 Subdivision Exemptions for Large Lots or Small Number of New Lots

Some subdivision regulations may have exemptions from conducting an environmental assessment for certain situations such as: (i) large lot subdivisions which will be resubdivided, or (ii) subdivisions that create a small number of lots and there is no anticipated construction.[120] These exemptions can lead to problems if lots and parcels are created that are too small to accommodate future hazard mitigation measures or another subdivision process.

It is recommended that lots along the coast or near a hazard zone not be severed without a hazard analysis. If a parcel is subdivided without an analysis, smaller lots could be created that are entirely within an erosion or hazard zone. A future landowner could then assert that these smaller lots have no economic use and seek compensation from the agency for attempting to implement strict hazard mitigation measures.

The hazard assessment should be conducted for any subdivision along the coast, regardless of size, intent on future construction, or future plans to resubdivide. An assessment will prevent the creation of substandard lots which cannot support a scientifically based safety buffer. Counties have and should consider placing restrictions on the first subdivision so that hazard mitigation is not compromised by future additional subdivisions.[121]

8.8 Notice to Future Occupants

The issue of notice to future occupants is covered in Chapter 10 – (Stage 6 - Lot Transfer). The subdivision regulations for Honolulu require the subdivider to notify future homeowners that the agency is not responsible for any repair or maintenance of

[119] Maui Subdivision Ordinance §§ 18.16.080, 18.16.210, 18.16.310
[120] Kauai County Shoreline Management Area Regulations Section 1
[121] Hawaii County Code § 22-38

private improvements.[122] It is recommended that the concept of landowner notice to future homeowners be addressed and expanded at the subdivision stage to include issues with regard to hazard mitigation (See Chapter 10). With proper disclosure of how a subdivision is designed to mitigate impacts from coastal hazards, the landowner will be rewarded with a more valuable project if proper mitigation measures have been implemented. Thus, there will be an economic incentive to subdivide in a safe manner.

8.9 Mitigating Hazards through Subdivision Design

How coastal lots and adjacent roads are laid out can make a significant difference in their susceptibility to hazards and the economic impact of mitigation efforts on the landowner. It is recommended that early, creative and flexible design be utilized in the creation of subdivision plans.

One of the basic concepts in subdivision design is to base the lot size on the size of the safety setback (Figure 8-1). This is directly opposed to the practice in Hawaii and many coastal states where the setback is often based on the size of the coastal lot due to the lack of early mitigation planning and the need to compensate for small lots which create regulatory takings issues.

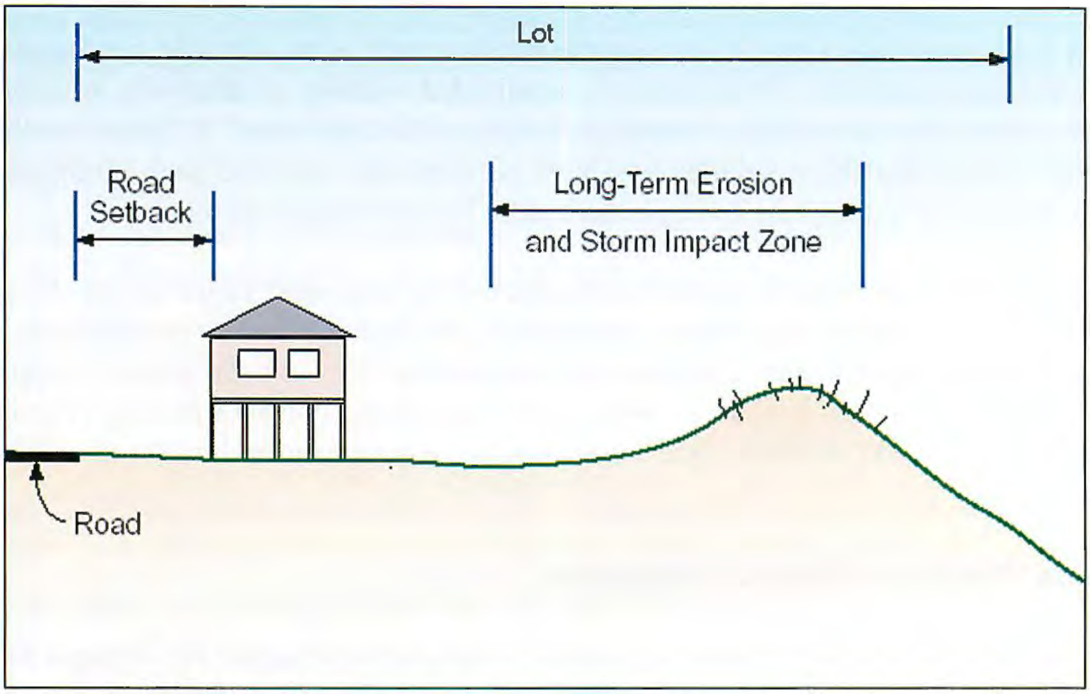

Figure 8-1 – Subdivision Lot Design - In the subdivision process, deep enough lots should be created to accommodate storm events, long term erosion and road setbacks (FEMA CCM, 2000). The counties would need to determine if the ocean setback should include the erosion and/or wave zone (Figure 3-1).

[122] Subdivision Rules and Regulations of the City and County of Honolulu § 5-503

The strategy in subdividing is to build deep, narrow lots along the coast with the houses built closer to the road than the shoreline. An example where deep lots have been created with houses built closer to the road than the shore is Kailua Beach on Oahu (Figure 8-2). This layout has led, in general, to the creation of a large coastal buffer zone than can accommodate shoreline movements without threatening residents. Furthermore, the buffer serves to preserve recreational uses in the area.

Figure 8-2 – Kailua Beach, Oahu – Deep lots were created with houses built closer to the road than the shoreline. This open space creates a scenic, recreational and hazard mitigation benefit.

If there is concern by the landowner that deep, narrow lots would deter buyers because the tax burden on the entire property is too large compared to the amount of buildable area, then one possible option, as a condition for subdivision approval, is to dedicate a shoreline buffer zone to the counties as a "Beach Reserve." In this way, the counties maintain open space while the cost of hazard mitigation is spread over the entire development and individual ocean-side property owners are not unduly burdened with having to pay for the buffer zone as part of their property.[123] During the subdivision process, land is commonly dedicated for public use through the vehicle of development agreements.[124] Development agreements often allow the counties to implement certain design standards, while the landowner is given the comfort that their project will proceed.[125]

[123] From Elaine E. Tamaye, Edward K. Noda and Associates, Inc.
[124] Revised Ordinances of Honolulu § 33-1.5(a)(5)
[125] Haw. Rev. Stat. § 46-121

Regardless if a Beach Reserve is created or not, the creation of deep, narrow lots along the coast should not be viewed as creating oceanfront space that is unusable. Potential homeowners can landscape the area and use the space for recreational and safety purposes (Figure 11-2).

Nags Head in North Carolina was able to change the manner in which subdivisions were designed (Figure 8-3). In this example, there was a distinct change in what types of subdivisions were allowed. It is within the authority of agencies to change design standards when there is a proper government purpose and notice. Also important is the recognition that if feeder roads are placed too close and parallel to the coast, the lots seaward of the road will not be able to accommodate a proper safety buffer.

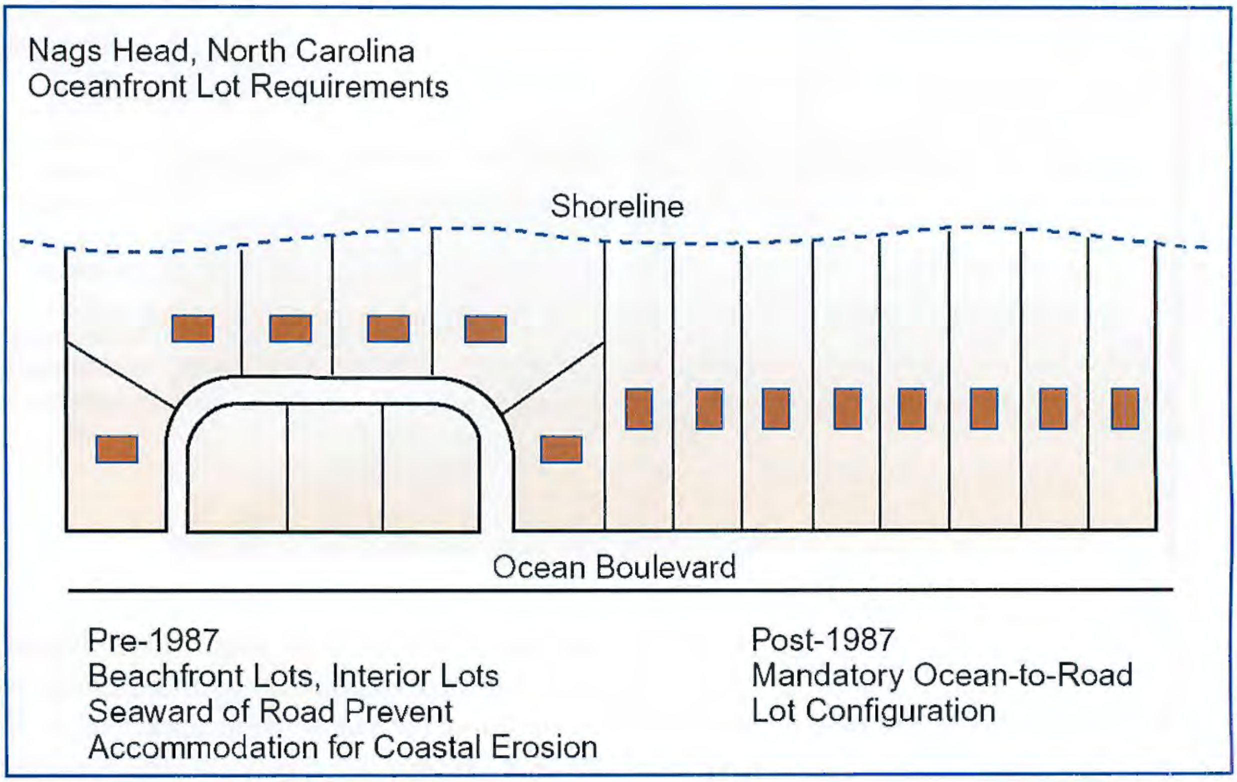

Figure 8-3 – Nags Head, North Carolina - Early subdivision design placed lots seaward of an arterial road that is parallel to the coast. The small lots cannot accommodate erosion. New design creates deep, narrow lots by eliminating the feeder road. The deep lots can better accommodate coastal hazards. From Morris, 1997 and FEMA CCM, 2000.

Sometimes feeder or arterial roads will be needed to serve coastal properties, especially if the main highway or street is far from the coast. The feeder road design would be partly a function of the size of the erosion or hazard zone and the location and size of the main roadways. If the creation of feeder roads parallel to the coast would interfere with the creation of the necessary safety buffer, then feeder roads perpendicular to the coast can be utilized (Figure 8-4). An example of arterial roads perpendicular to the coast feeding shoreline properties is at Kailua Beach on Oahu (Figure 8-5).

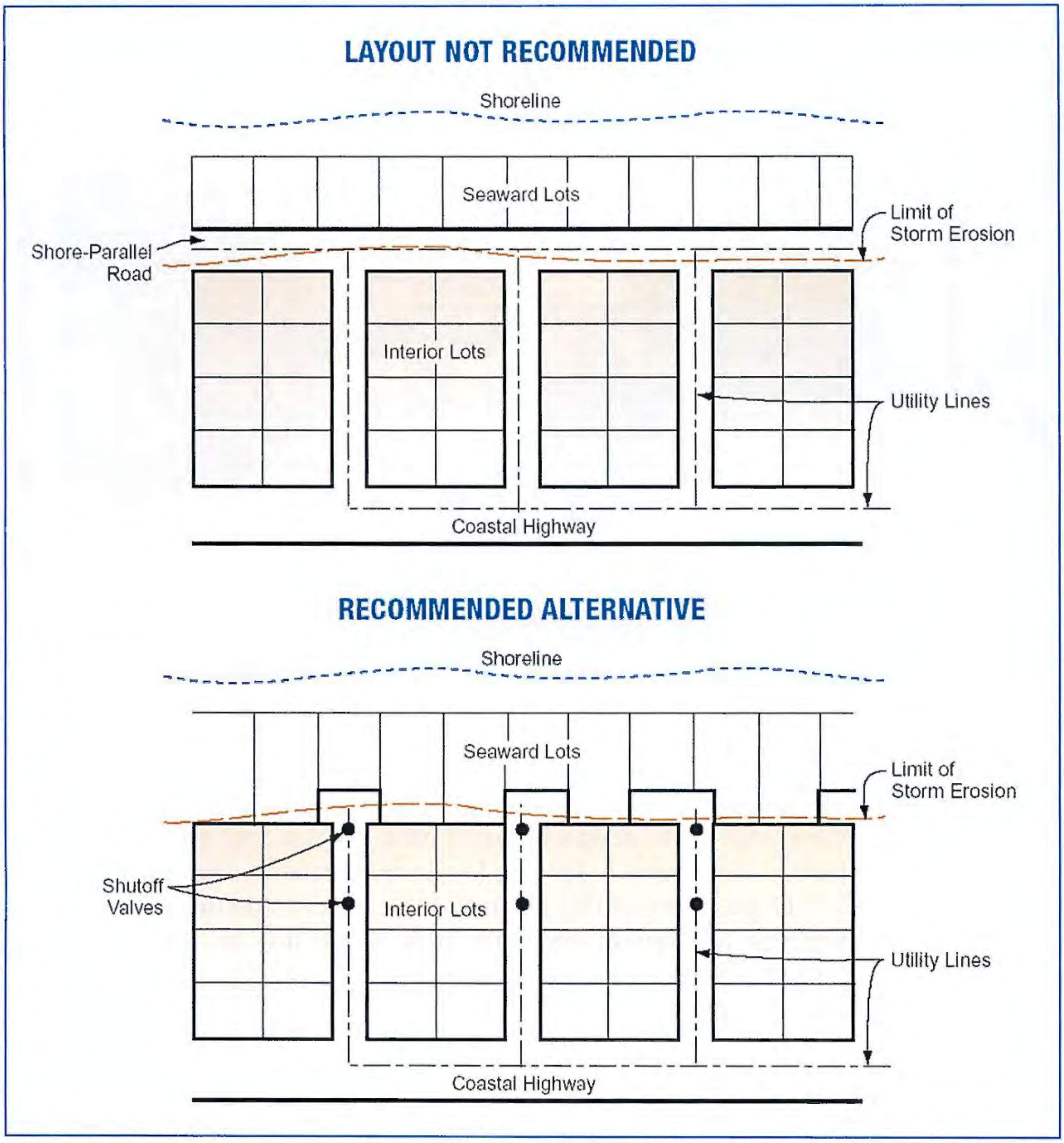

Figure 8-4 – Subdivision Design for Feeder Roads - Feeder roads that are parallel to the shoreline may restrict coastal lot size and necessitate the placement of utilities where they are subject to storm erosion or flooding (Top). An alternative is to eliminate the shore parallel road and serve coastal lots with roads perpendicular to the coastline (Bottom). This will facilitate the creation of deeper narrow lots along the coastline. Shut off valves for utilities can be placed on the feeder roads. From FEMA CCM, 2000. Smaller lots along the shoreline in the lower configuration may be redesigned for ocean access, public use, or can accommodate a smaller house. Regulatory flexibility is key.

Figure 8-5 – Kailua Beach, Oahu – Feeder Roads - Example of a coastal lots being served with feeder roads perpendicular to the shore. Lots are deep and accommodate a sufficient setback (Figure 8-2). The ocean is in the background.

Another problem may be to design houses with a flag lot configuration along the coast. County ordinances may provide for flag lots in areas where access to the street is limited.[126] However, the geometry of flag lots may force the construction of homes close to the shoreline, whereas a different geometry may allow just as many units with considerably less exposure to coastal hazards (Figure 8-6).

[126] Honolulu Land Use Ordinance Article 4 § 21-4.20

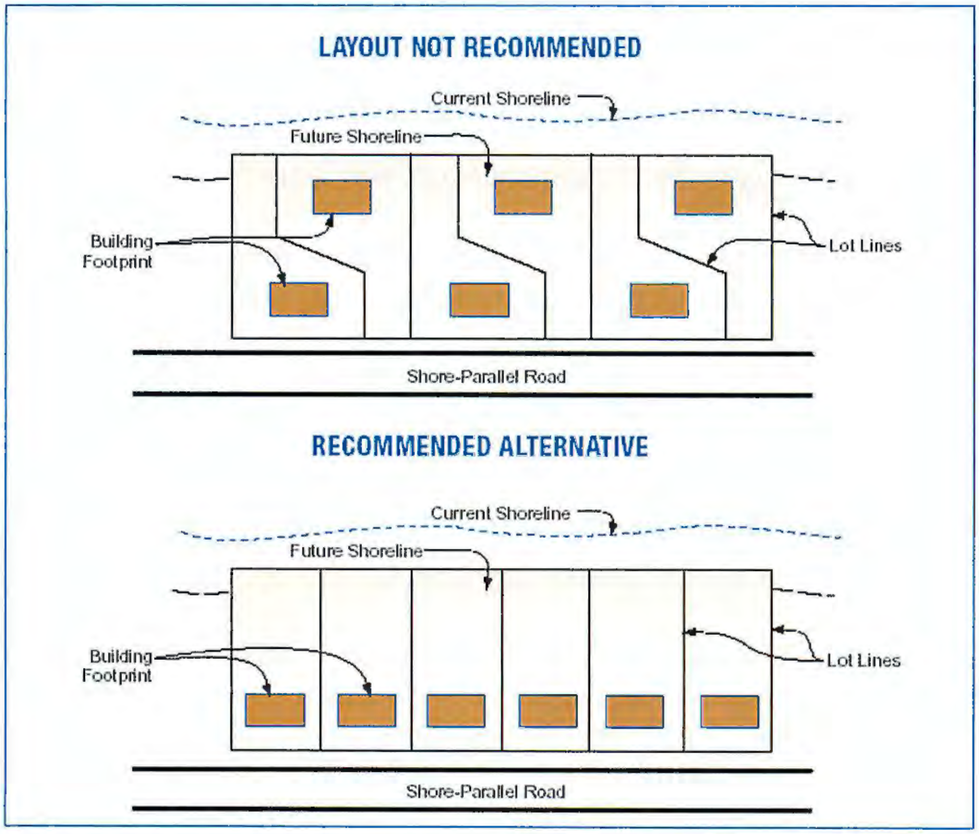

Figure 8-6 – Subdivision Layout Design - Comparison of subdivision with flag lot configuration versus the recommended alternative of creating deep narrow lots along the shore. The flag lot configuration in this example forces construction of homes within an anticipated erosion zone. From FEMA CCM, 2000.

Figure 8-6 illustrates how an equal number of deep narrow lots can be placed along the coast as compared with the flag lot configuration. With proper disclosure of erosion and flooding risks to future homeowners (Chapter 10), the houses with deep narrow lots will have significantly higher market value than the flag lots. Furthermore, the occupants will be safer and there will be less potential liability.

8.10 Land Use Tools in the Subdivision Process

8.10.1 Planned Unit Developments, Planned Developments

It has been recognized that if a developer has greater flexibility in laying out their lots, they could better conserve the physical attributes of the property and better incorporate environmental best practices.[127] This could lead to greater safety buffers, less environmental damage and reduced economic impact. The County of Hawaii encourages innovative use of land with respect to geologic and topographic features with the use of residential cluster and Planned Unit Developments ("PUD").[128]

This manual encourages the utilization of PUDs as a tool to properly construct along the coast. For Hawaii County, PUDs are encouraged so that comprehensive

[127] Kauai General Plan – p. 5-8
[128] The General Plan Hawaii County Section 4(M)(5)

planning adapts the design of development to the land by allowing diversification of uses, buildings, structures, open spaces, yards and lot sizes.[129] The PUD in Hawaii County constitutes an environment of sustained desirability and stability for the district that is in harmony with the surrounding area, that results in an intensity of land use no higher than specified in the district and that maintains the standards of open space.[130]

It is the flexibility in lot sizes and geometry that makes the PUD so useful in hazard mitigation. For hazard mitigation purposes, residential lots along the coast should be long and narrow to accommodate a deep setback. Since these coastal lots may take up a large percentage of the total area of the project, there may be concern by the landowner that the remaining area only allows a small number of large inland lots to be developed. By allowing for greater flexibility in lot size, large deep lots can be created along the coast with small lots away from the coast so that the total number of lots remains the same even with a very large safety setback. This would not be possible if all the lots had to be very large, (e.g., a minimum size of 20,000 square feet).

In Maui County, mixture of lot sizes may be permitted within any residential district, provided that the minimum lot size shall not be less than 6,000 square feet and the overall project density shall not exceed that permitted within the district.[131]

For the City and County of Honolulu, planned development housing (PD-H) is a vehicle to allow flexible residential development on large parcels of vacant land while complementing the surrounding neighborhood.[132] The PD-H allows for a variety of housing types, innovative site design, and most importantly the mixing of uses, lot geometries and sizes.

8.10.2 Project Districts

Another useful tool for land use design is the Project District, which is intended to provide for a flexible approach rather than specific land use designations. The Project District is usually larger than the PUD and mixed uses are allowed (e.g., residential and commercial).

Hawaii County has a Project District which requires a minimum land area of 50 acres.[133] It allows for flexibility in location of specific uses, and mixes of structural alternatives. This planning approach provides for a continuity of land uses and designs while providing for infrastructure, open space and parks.[134] An indication of the flexible

[129] Hawaii County Code § 25-6-1
[130] Hawaii County Code § 25-6-10
[131] Maui County – Comprehensive Zoning Ordinance – § 19.08.040(B)
[132] Honolulu Land Use Ordinance Article 8 § 21-8.50-4
[133] Hawaii County Code § 25-6-40
[134] Hawaii County Code § 25-6-43, Maui County – Comprehensive Zoning Ordinance – § 19.45.010(B)

approach is indicated by the mix of permitted residential uses.[135]

The layout of a Project District is usually contained in a Master Plan. Similar to the recommendation for subdivisions, the issue of hazard mitigation measures should not be raised after the Master Plan is finished, but before the design for the Master Plan has begun. This would require a hazard assessment early in the process to determine potential areas of concern that should be kept open.

Maui County has a Project District for Manele Bay on Lanai that requires a setback of 300 feet from any beach and that 95% of all dune areas should remain as open space.[136] The setback in this area demonstrates the feasibility of large coastal setbacks when they are planned for early in the development process.

8.10.3 Cluster Development

Clustering serves to minimize grading and makes optimum use of the terrain for buildings and open space. Hawaii County strongly encourages the use of cluster developments and planned unit developments to better design with natural topography.[137] Cluster development is especially useful if a county needs to control development over a very large area (e.g., the erosion and wave zones).

The counties typically have provisions for cluster development.[138] In Hawaii County, clusters are used to provide exceptions to density requirements of the single family district so that permitted density of dwelling units contemplated by the minimum building site requirements is maintained on an overall basis and desirable open space and recreation areas are preserved.[139] This desirable open space can be concentrated along the shore to provide the buffer zone needed for hazard mitigation.

For the City and County of Honolulu, cluster development provides for flexibility in housing types, encourages innovative site design and allows development which may be difficult under conventional subdivision standards.[140] In addition, cluster development is allowed in country districts.[141] The purpose of country clusters is to encourage the retention of large tracts of open space which contribute to the rural character.

In Maui County, the cluster development is recommended: (i) for areas difficult to develop under conventional subdivision standards, (ii) to allow flexibility in housing

[135] Hawaii County Code § 25-6-43
[136] Maui Comprehensive Zoning Ordinance § 19.70.100(A) and (B)(10)
[137] The General Plan Hawaii County § 4(M)(5)
[138] Maui Comprehensive Zoning Ordinance § 19.83, Hawaii County Code § 25-6-20, Honolulu Land Use Ordinance Article 8 § 21-8.50-1
[139] Hawaii County Code § 25-6-20
[140] Honolulu Land Use Ordinance Article 8 § 21-8.50-1
[141] Honolulu Land Use Ordinance Article 3 § 21-3.60-1

types, (iii) to encourage innovative site design and efficient open space, and (iv) to minimize grading.[142] The cluster development in Maui was conceptually designed to address hazard mitigation since a requirement in the application is to show areas subject to storm water overflow, slide areas, and other features likely to be harmful to the project or surrounding areas.[143]

The cluster concept is nontraditional, but has been used in Maui to simultaneously increase density and open space for inland areas.[144] Such a concept can be applicable to coastal areas, but it is important that a hazard assessment be conducted before work on the preliminary plat begins, so that resources on an inadequate design are not expended.

An example of how clusters can be used to create a safety buffer between development and the ocean is shown in Figure 8-7. In this Figure, the inland limit of open space is the V zone (equivalent to the wave (V-VE) zone). Whether the counties decide to limit development in the wave (V-VE) zone should be addressed in the hazard assessment. A restriction on development in the erosion zone is recommended.

The cluster development concept does not have to be applied to the entire coastal parcel. A property with unusual geometry that undulates along the coast can combine concepts of the cluster development with the planned development to more efficiently utilize developable and open space.

8.10.4 Variances and Exceptions

Counties generally have provisions in their regulations for variances that allow deviation from zoning or subdivision regulations for hardship to the applicant, or for other just causes. For example, some counties may allow variances, exceptions or modifications which can result in flexible design in development.[145]

A system of variances, exceptions or modifications can be used for parcels about to be subdivided but not suitable to go through the PUD or cluster process due to the relatively small size of the project, limited resources or other reasons. A key factor that the variances could address is increased flexibility to mix lot sizes and geometries. With that flexibility, the increased safety buffer along the coast can be maintained while reducing objections about economic impact.

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[142] Maui Comprehensive Zoning Ordinance § 19.83
[143] Maui Comprehensive Zoning Ordinance § 19.83.040 (B)(3)(d)
[144] Personal Communication with Maui County Planner – Darren Suzuki
[145] Maui Subdivision Ordinance § 18.32.020; see also Modification Provisions – Subdivision Rules and Regulations of the City and County of Honolulu § 1-112

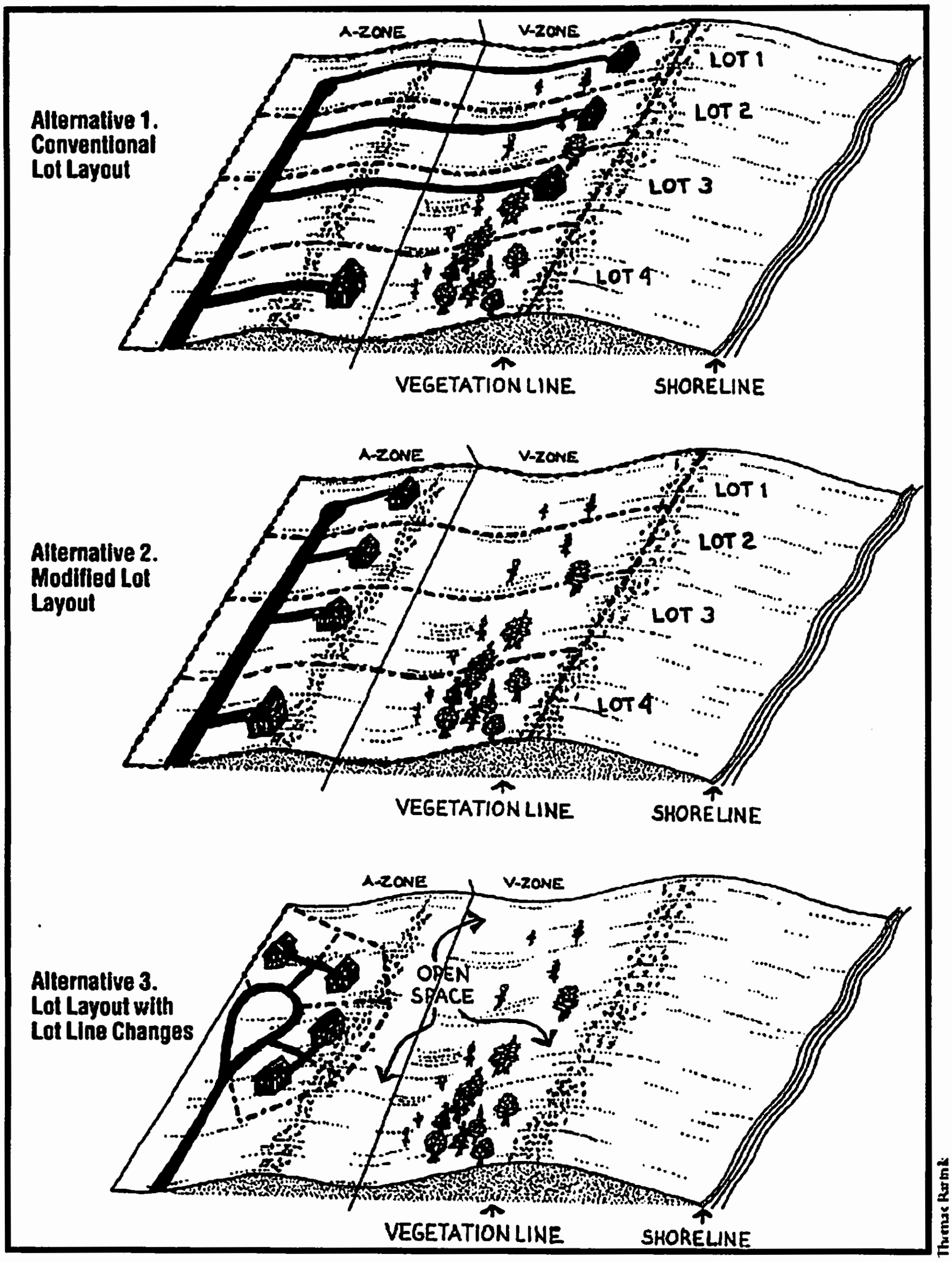

Figure 8-7 – Cluster Development - Comparison of Conventional lot layout compared with a modified lot layout and cluster layout to create a safety buffer zone from the ocean. From FEMA CCM, 2000 and Morris, 1997; adapted from California Coastal Commission, 1994.

8.11 Subdivision Summary

The concepts covered in this Chapter are summarized in Figure 8-8 and can be used during the subdivision process to reduce the risks of coastal hazards to future occupants.

Hazard Mitigation Guidelines for Subdivision Design along the Coast

- The agency and applicant should meet before the preliminary plat is worked on to discuss hazard mitigation, expected safeguards for future occupants and creative design. Current county rules allow such a meeting but do not require it.
- Conduct a hazard assessment with erosion analysis before design of the preliminary plat (Chapters 3 and 4). The hazard assessment can later become part of the environmental assessment that would be required for a Special Management Area permit.
- Use a planning period of 100 years for large structures, or structures that are undetermined. For smaller wood frame structures, a period of 70 years may be suitable.
- From the hazard assessment, place the erosion, wave (V-VE), flood (A-AE-X) and inland zones as well as the Base Flood Elevations on the preliminary plat.
- Avoid development in the erosion zone. The hazard assessment should consider if the wave (V-VE) or flood (A-AE-X) zones should be avoided or if these hazards can be addressed in the construction stage. No critical facilities should be in the erosion, wave (V-VE) or flood (A-AE-X) zones.
- Maximum flexibility is needed with regard to lot size, mixing of lot sizes, and geometry of lots to accommodate the proper safety buffer and allow economic use.
- Encourage the use of creative design by utilizing the flexibility provided for in planned unit developments, planned developments, project districts, cluster developments, variances and other land use provisions.
- Create deep, narrow coastal lots to accommodate the proper safety setback. More numerous, smaller inland lots can allow the same number of total units in a project as with a traditional design, but with much greater safety for future occupants.
- Encourage proper subdivision design by actively addressing hazard mitigation during all stages of development, but in particular during, district reclassification (Stage I), general and community plans (Stage II), zoning (Stage III), and lot transfer (Stage VI – see Chapter 10).
- Build stronger and site better to insure the subdivision is suitable for its intended use (occupants are adequately protected from erosion and flooding for a period of 70 to 100 years).
- Address hazard mitigation for large lot subdivisions along the coast so that additional subdivision of the land does not defeat efforts to provide an adequate safety buffer.
- Require as a condition for subdivision or SMA approval, full disclosure to prospective purchasers of subdivision lots on the location of the erosion, wave (V-VE), flood (A-AE-X) and inland zone, as well as any county policy for shoreline hardening that may apply to new projects (See Chapter 10).

Figure 8-8 – Hazard Mitigation Guidelines for New Coastal Subdivisions

Chapter 9 – Infrastructure Improvements (Stage 5)

Infrastructure improvements for development include the grading of land, the placement of streets, and the laying of utilities to be used for future developments. This stage is usually concurrent with the subdivision approval process and is marked by the submission of construction plans and specifications for improvements. Approval by the agency allows the subdivider to proceed with construction of the improvements and utilities.[146]

Many of the standards for infrastructure improvements are found in the individual county's subdivision regulations. However, while county Planning Departments are involved in approval of the subdivision, it is the Public Works Department which plays a greater role for the actual improvements (Table 2-1).

Separate from the subdivision process, actual grading of the land is covered by the grading permits for the individual counties. These grading permits often require a Best Management Practices Plan. An important part of that plan should be the protection of the coastal dune, a topic which will be covered in detail in this Chapter.

9.1 Road Layout

The layout of roads is usually part of the subdivision process and the infrastructure or site improvement process. The site improvement approval process usually requires a map showing the location of lots and streets, the location of water lines, sewer mains, drainage systems and other utilities.[147]

The location of major roadways, as well as feeder or arterial roads plays a direct role in the size and geometry of coastal lots. Road layout should be designed to insure that lots seaward of the road can accommodate erosion, inundation and flooding risks (Chapter 8). For many counties, street design must take into account the county general plan and topographical conditions at the site.[148]

9.2 Electrical and Utilities

Flood regulations may require that all new electric and other utility, communication services, and facilities located within flood plain areas be constructed and located in a manner which will minimize the risk of flood damage.[149] Kauai County has standards that require that the incoming service equipment and metering, as well as

[146] Maui Subdivision Ordinance § 18.20.180, Subdivision Rules and Regulations of the City and County of Honolulu § 6-601(c)(7), Hawaii County Subdivision Control Code §§ 23-79, 23-80
[147] Maui Subdivision Ordinance § 18.20.150(B)
[148] Hawaii County Subdivision Control Code § 23-40, Subdivision Ordinance for the County of Kauai § 9-2.3
[149] Kauai County Code § 9-2.7

stationary equipment such as transformers be located above the regulatory flood level or made waterproof.[150] In general, all utilities should be located, elevated or flood proofed to avoid or reduce the risks of erosion and flood damage.

9.3 Dune Protection

Coasts are by nature dynamic environments. Coastal features such as beaches and dunes are continuously moving and being reshaped in response to changing wind and wave conditions. During periods of high wave energy, sand may be removed from beaches and dunes and deposited offshore. This sand then usually migrates back to the shoreline during calmer environmental conditions, allowing the beach and dune to rebuild (Norcross, Sea Grant, 2002) (Figure 1-1).

In addition to providing sand to the beach during periods of high wave energy, coastal dunes play an important protective function in preventing flooding and inundation by creating a barrier against the elements. Grading dunes to make a smooth surface for development can therefore increase the risk of erosion, flooding and wave inundation. To the extent possible, the natural contours of the land should be maintained and dunes preserved.

Vegetation is an important factor in stabilizing coastal dunes. Plant leaves and stems trap blowing sand, encouraging the buildup of the dune. Where vegetation is absent, sand often blows over and beyond the dune, becoming lost from the active beach system and creating blowouts in the dune. Blowouts diminish the flood-protection capacity of the dunes (Norcross, Sea Grant, 2002).

The natural vegetation in the erosion zone should be maintained because it is likely to be salt tolerant and well established. When the vegetation is not well established, dunes are more likely to be completely removed during a storm event (FEMA CCM, 2000 – Chapter 7). This will expose backshore areas to flooding and inundation. However, if the dune is not removed, it will retreat but still protect backshore areas (Figure 9-1). Key in the protective properties of the dune is the size of the frontal dune sand reservoir and the condition of the vegetation. The more established the vegetation (in existence greater than two years) and the thicker the root system, the more protection will be provided by the dune. In Hawaii, the size of the frontal dune may range from substantial to insignificant.

[150] Building Code of the County of Kauai § 13-5.3

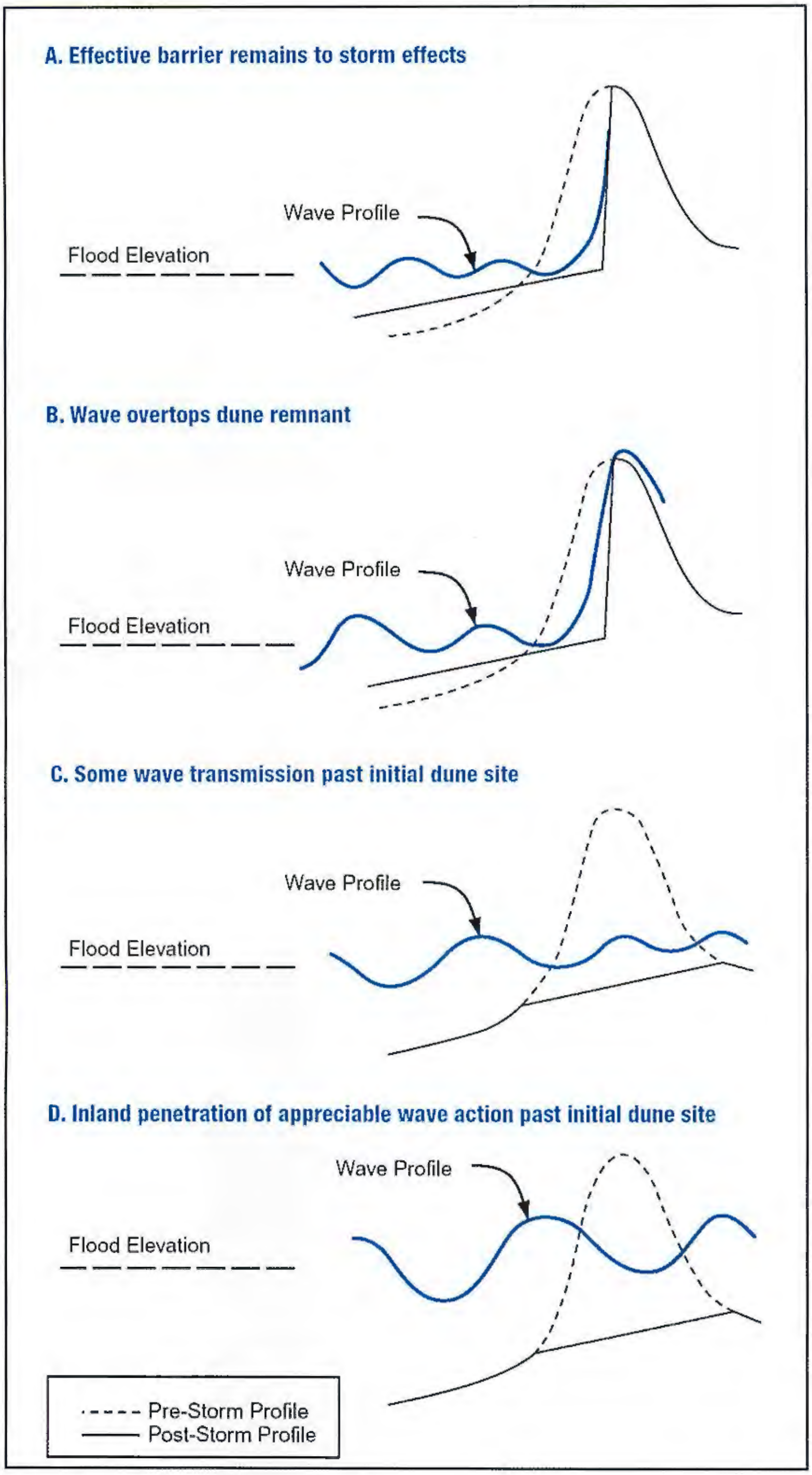

Figure 9-1 – Role of Dunes in Protection of Inland Areas. In A, small waves above a flood elevation are contained by the dune, but the dune retreats from its original profile. Backshore areas are protected. In B, larger waves over the flood elevation overtop the dune. Backshore areas are subject to slight flooding. In C, the dune has been removed, exposing backshore areas to flooding and smaller waves. In D, larger waves remove the dune and expose backshore areas to significant flooding and wave action. This diagram demonstrates the importance of maintaining the dune and coastal vegetation to protect inland areas from flooding, wave inundation and erosion. From Dewberry & Davis 1989 and FEMA CCM, 2000.

Natural vegetation in the Hawaii coastal environment includes naupaka, beach morning glory (pohuehue), 'aki'aki grass, and akulikuli (Figure 9-2). These plants are salt tolerant, have dense root systems, and are therefore, effective wind breaks and wave buffers (UH Sea Grant Extension Service, Beach Management Plan for Maui, 1997).

Figure 9-2 – Coastal Vegetation - Naupaka (broad green leaves - left), Beach Morning Glory (thin green leaves – center) and 'Aki'Aki grass (brown tall grass - right) are able to tolerate salt water and grow seaward, thus binding the sand and forming a thick mat.

Natural vegetation should be kept for at least the frontal dune and back or secondary dunes in the shoreline setback area and the erosion zone as defined in this manual (Figures 3-1, 4-4 & 9-3).

Figure 9-3 -- Coastal Vegetation at Kailua Beach, Oahu - The thick mat of Naupaka (right), Beach Morning Glory (center) and 'Aki'Aki grass (left) covers the dune, thus protecting the backshore against temporary periods of erosion.

If the natural vegetation for the back dunes is not kept (e.g., in the wave (V-VE) zone), the contours of the dune can still be maintained during development and the project is likely to have an undulating appearance which can still be planted with other types of appropriate coastal vegetation (Figure 9-4). It should be noted, however, that the alteration of dunes needs to follow the National Flood Insurance requirements at the county level (see Table 11-2).

Figure 9-4- Wailea Elua, Maui – The areas seaward of the buildings are maintained as open space and the topography has an undulating appearance due to the lack of grading and the maintenance of natural contours.

If the grade needs to be evened because of high development pressure, instead of removing dune sand, or infilling with soil, the low areas can be in filled with sand suitable for eventual placement on the beach. Rough guidelines for beach quality sand are found in a proposed Department of Land and Natural Resources general permit for small scale beach replenishment projects in Hawaii. The standards are summarized in Figure 9-5. The reader should consult with the DLNR for any changes to the proposed standards. These standards could also apply to fill that is added during grading in the erosion zone.

The agencies can decide if beach quality sand or near beach quality sand should be used in the erosion zone. Either would be an improvement over the use of soil. Note that in the erosion zone, construction should generally be prohibited. Thus, whether the physical characteristics of the infill sand can support a structure should not be an issue.

By following a practice of infilling low areas with sand, the erosion of the dune will supply sand to the beach instead of soil. This will serve the dual purpose of slowing erosion and minimizing water quality impacts which occur when soil horizons with a concentration of fine material are eroded by wave action (Figure 9-6).

Sediment Standards for Beach Replenishment or Infill during Grading in the Erosion Zone

- Local quarries can be contacted to inquire about the availability of beach quality or near beach quality sand.

- Sieve analysis can be utilized to determine the size distribution of the existing beach and the proposed fill (ASTM standards D-1140-92 and D-22-17-93). Sieve analysis passes sediment through a series of pans with different size perforations that separate fine from coarse sediment. Fill can be used for beach replenishment or to level the grade in the shoreline setback area or the erosion zone.

Sediment Standard for Beach Replenishment (Beach Quality Sand)

- The fill sediment shall contain no more than 6 percent fine sediments, defined as the #200 sieve (0.074 mm). This number may be adjusted by a Panel of Technical Experts (PTE) or the DLNR Chairperson based on an analysis of native beach sand.

- The fill sediment shall contain no more than 10 percent coarse sediments, defined as the #4 sieve (4.76 mm). This number may be adjusted by a Panel of Technical Experts (PTE) or the DLNR Chairperson based on an analysis of native beach sand.

- The grain size distribution of the fill shall fall within 20 percent of the existing beach sediment, as measured by cumulative percent-finer-than (or percent-coarser-than) values. For example, if the existing beach sand contains 45 percent grain size finer than the #100 sieve, the fill must contain between 25 percent and 65 percent grain size finer-than the #100 sieve. Alternatively, and for cases where the fill grain size distribution is uniformly finer than the existing beach, the overall fill ratio of the fill sediment relative to the existing beach shall not exceed 1.5. See Coastal Engineering Manual V-4.1.e.3 Sections h and I on sediment suitability and overfill factor. http:/www.wes.army.mil/export/home/http/htdocs/chlc/prtV-Cap4.pdf.

- No more than fifty per cent of the grain size distribution of the sediment shall be smaller than .125 millimeters in diameter (Hawaii Administrative Rule § 11-54-07(a)(3)(C)).

- Beach fill shall be dominantly composed of naturally occurring carbonate beach or dune sand. Crushed limestone or other man made or non carbonate sands are unacceptable.

- Borrow material should be free of contaminants and monitored for variability to assure conformity with the above standards.

Sediment Standard for Infill in the Erosion Zone (Near Beach Quality Sand)

- Agencies can decide to require beach quality sand for infill in the erosion zone or to relax the standards and require near beach quality sand.

- An example of a relaxed standard would be to allow sand with 15% fine material. The availability of local sand sources may play a role in this determination.

Figure 9-5 – Standards for Beach Quality Sand. Sand meeting the above standards can be used as replenishment for beaches (Chapter 11) or for the infill of coastal areas that are in the erosion zone. Adapted from the Draft State of Hawaii Department of Land and Natural Resources proposed General Permit for Small Scale Beach Nourishment Projects (2004).

Figure 9-6 – Aliomanu Bay, Kauai – Erosion of the shoreline and the soil profile threatens the house and impacts water quality. These impacts can be mitigated with the proper setbacks and by using sand that meets the standards in Figure 9-5, instead of soil as fill in the erosion zone. Photo by Dennis Fujimoto of Garden Island News

One concern that may be raised regarding the use of infill sand in the backshore area (i.e., behind the frontal dune) is that it may prohibit the area from being landscaped or it may result in the removal of natural vegetation. This problem can be alleviated by using other adaptive and salt tolerant coastal plants and grasses.

The grass seashore paspalum has a high salt tolerance and is adaptable, making it a good choice for coastal areas subject to salt spray or periodic high-wave inundation (College of Tropical Agriculture and Human Resources, University of Hawaii, 1998). Furthermore, the grass grows naturally in the coastal environment, and in many cases, from the dune itself. Any inland flooding will not kill the grass and thus weaken the vegetation that strengthens the back dune system.

Seashore paspalum can also help to conserve water because it is salt tolerant and can be irrigated with brackish water. Herbicides are not needed because salt water can be used to kills weeds. The grass grows in a variety of soil types, including sandy soils (College of Tropical Agriculture and Human Resources, University of Hawaii, 1998). The grass can grow on ocean beaches, directly from the sand with little or no soil needed (Figure 9-7).[151]

[151] See also University of Florida Turfgrass Science website

Figure 9-7 – Ko Olina, Oahu – Salt tolerant vegetation such as the grass seashore paspalum can grow directly on the sand with little or no soil. The grass can withstand periodic flooding and is suitable for areas graded with a minimum of soil infill.

Seashore paspalum may be appropriate for areas behind the frontal dune but still in the erosion zone. For the frontal dune itself, maintaining the natural vegetation and contours is the preferred alternative. The use of substitute vegetation on the frontal dune should only be a last resort in situations where there is high development pressure.

For the wave (V-VE) zone, the first option would be to maintain the natural vegetation and contours. If substitute vegetation is used, it should be salt tolerant to survive flood and wave inundation events. The concept of using vegetation as a buffer against wave action has been previously proposed. In the report, "Designing for Tsunamis," tsunami forests can be created to shield inland structures from inundation (National Tsunami Hazard Mitigation Program, 2001).

In the flood (A-AE-X) zone, if there is any removal of natural vegetation, it should be replaced with vegetation that is salt tolerant to survive flooding events. There are no guidelines for improvements in the inland zone.

Table 9-1 summarizes the recommended options for the erosion, wave (V-VE), flood (A-AE-X) and inland zones (Figure 3-1). The recommendations in this Chapter for grading in the various hazard zones are meant to supplement the requirements for grading under the National Flood Insurance Program (see Table 11-2 – column 2).

Location	1st Option	2nd Option
Frontal Dune in Erosion Zone	(1) Maintain natural vegetation and contours. (2) Rebuild blowouts or damaged dunes with (i) beach quality sand and (ii) natural vegetation. (3) The rebuilt area should not be used in the shoreline certification process to extend the "shoreline," or area of development seaward.	(1) Infill with beach quality or near beach quality sand (Figure 9-5). (2) Use substitute vegetation that is adaptive and salt tolerant only as a last resort for the frontal dune. (3) The rebuilt area should not be used in the shoreline certification process to extend the "shoreline," or area of development seaward.
Back Dunes in Erosion Zone	(1) Maintain natural vegetation and contours.	(1) Infill with beach quality or near beach quality sand. (2) Utilize appropriate coastal vegetation to prevent erosion, wave and flood damage.
Wave (V-VE) Zone	1) Maintain natural vegetation and contours.	(1) Substitute appropriate coastal vegetation to prevent wave and flood damage. Salt tolerant vegetation can survive inundation and wave barriers can be designed similar to a tsunami forest.
Flood (A-AE-X) Zone	(1) Utilize appropriate coastal vegetation to prevent flood and possible wave damage.	(1) Substitute appropriate coastal vegetation that is salt tolerant and adaptive such as seashore paspalum.
Inland Zone	No Requirements	No Requirements

Table 9-1 – Recommendations for Grading in the Erosion, Wave (V-VE), Flood (A-AE-X) and Inland Zones - The suggested options differ depending on distance from the coastline. Reference should be made to the National Flood Insurance regulations for the various counties which may place restrictions on dune alteration in V-VE zones (see Table 11-2).

A best management practice ("BMP") for the grading and grubbing in the shoreline area has been developed by the Maui County Department of Public Works.[152] This BMP, along with the concepts and recommendations in this chapter are combined and summarized in Figure 9-8.

[152] Maui County Department of Public Works Construction Best Management Practice – Draft – September, 2002

Best Management Practice ("BMP") for Grading in the Shoreline Setback or Erosion Zone

- Any grading to occur in the shoreline setback area and the erosion zone should be minimized. Where possible, the natural contours and undulations within this area should be preserved.
- No sand should be removed from the property. Any grading of sand that occurs on the property should relocate the sand within the shoreline setback area or the erosion zone.
- Fill placed seaward of the dune line, within the shoreline setback area or erosion zone should meet the local requirements for beach quality sand (Figure 9-5).
- Rebuilding of a coastal dune that has suffered erosion or degradation, with beach-quality sand and suitable vegetation is encouraged.
- Sand that is blocking a drainage outlet and that poses a potential flood hazard may be removed to the minimum depth necessary to eliminate the flood hazard. The sand plug removed should be placed on the adjacent beach. Where predominant winds are from an angle, the removed sand plug should be placed on the down-wind side of the outlet to prevent its being blown back into the outlet.
- Grubbing on coastal dunes is discouraged, except where the vegetation being removed will be immediately replaced by alternative vegetation suitable to a coastal dune environment, for example Naupaka, Beach Morning Glory (Pohuehue), Akulikuli or Aki Aki grass.
- Where wind-blown dunes exist, construction of elevated walkover paths for beach access, and closure of blow-outs and gaps in dunes is encouraged.
- Planting of salt-resistant vegetation to help stabilize coastal dunes or the backside of dunes is encouraged.
- If grading and grubbing does occur behind the frontal dune, salt tolerant and adaptive coastal vegetation should be used. Seashore paspalum is a recommended turf grass. The College of Tropical Agriculture & Human Resources of the University of Hawaii should be contacted for suitable vegetation.
- Utilize the recommendations in Table 9-1 for grading, grubbing or other improvements in the erosion, wave (V-VE), flood (A-AE-X) and inland zones.

Figure 9-8 – Grading Best Management Practice - The above practices will help to preserve the coastal dunes, which serve as a buffer to reduce the risk from erosion, wave inundation and flooding. Adapted from Maui County Department of Public Works Construction BMPs – Draft – September, 2002.

9.4 References for Hazard Mitigation during the Infrastructure Improvement Stage of Development

Important references with regard to hazard mitigation during the infrastructure improvement stage of development include: (i) the FEMA CCM (vols. I through III) and (ii) the flood insurance regulations for the particular counties. For a useful reference on native coastal vegetation, the reader is referred to the book "Hawaiian Coastal Plants and Scenic Shorelines," Merlin, 1977.

The public works and planning departments for the various counties can also be contacted regarding infrastructure improvements and hazard mitigation (Table 2-1).

Chapter 10 - Lot Purchase (Stage 6)

There is anecdotal evidence of instances where parties have purchased coastal properties without fully appreciating the risks from erosion, wave inundation and flooding. When problems are discovered, the landowner is likely to become desperate and panic, often taking action to harden the shoreline without permits or moving to sell the property.

Disclosure of erosion, flooding and inundation risks serves several purposes. With proper disclosure, the purchaser of a coastal home or lot is better informed of the risks of natural hazards. To a knowledgeable buyer, coastal homes and lots that are designed to mitigate for coastal hazards are more valuable than properties in which this risk has been ignored. That proper hazard mitigation design is important to potential buyers is both intuitive and supported by actual experience. For example, residents at Sugar Cove on Maui have testified that they would not have purchased shoreline property until the problem with erosion and wave inundation was mitigated with an apparently successful sand replenishment project. Until that project, waves often crashed against a boulder wall, inundating properties and causing considerable stress for the residents (Figure 1-10).

From the landowner/developer prospective, disclosure of hazard risks creates an incentive to design projects, subdivisions or lots that avoid hazard problems. This is because the combination of a poorly designed (substandard) lot and a knowledgeable buyer will reduce market value. The developer benefits from proper hazard mitigation design by offering a more valuable product and establishing a quality reputation.

Aside from protecting the buyer and providing incentive for the landowner to implement hazard mitigation measures, seller disclosure laws promote economic efficiency. Hawaii's disclosure law was implemented, in part, after statistics showed that a leading cause of real estate litigation was due to the failure to disclose material facts regarding a property (Nakasone, 1997).

There is one Federal and two State consumer protection laws related to the potential disclosure of hazard risks. Although these laws are potentially useful, significant gaps limit their capability to assist in the implementation of hazard mitigation strategies. These laws are summarized below along with suggested changes for improvement to the two State laws.

10.1 Mandatory Seller Disclosures in Real Estate Transactions

The Mandatory Seller Disclosures in Real Estate Transactions Act ("Mandatory

Disclosures Act") was passed in 1994.[153] This law requires the seller or the seller's agent to prepare a disclosure statement in good faith and with due care regarding material facts that would be expected to measurably affect the value to a reasonable person of the residential real estate being offered for sale.

Related to hazard mitigation, disclosure is expressly required for residential property in the special flood hazard area.[154] These are areas on the Federal Insurance Rate Maps subject to the 100-year flood and are equivalent to FEMA's V, VE, A and AE zones. Disclosure is also required for anticipated inundation areas designated on the Department of Defense's civil defense tsunami inundation maps.[155] The maps for tsunami and flood inundation are required to be kept by the counties and disclosure is required only if the maps are present and relate the hazard zone to the tax map key of a property.

Although flooding and tsunami inundation are expressly addressed in the Mandatory Disclosures Act, erosion is noticeably absent. Intuitively, erosion is a material fact that would require disclosure. From Figure 3-1, structures in the flood zone may be subject to flooding and tsunami inundation, since Hawaii's FIRMs factor tsunami inundation into the V and A zones. Generally, structures in the erosion zone would be subject to the most intense tsunami and flooding forces, as well as erosion and scour. Furthermore, from Table 3-1, erosion is a coastal hazard that should be addressed as a siting issue, whereas tsunami inundation and flooding can in most cases be addressed during the construction stage.

The Hawaii Supreme Court has indirectly indicated that erosion is a material factor to disclose. The Court ruled that a shoreline property boundary that was in dispute was a material fact that required disclosure.[156] Erosion changes the location of shoreline property boundaries, resulting in diminution of coastal lot size over time.[157]

The Hawaii legislature should consider amendment to the Mandatory Disclosure Law to expressly address erosion. In Figure 10-1 some recommended changes to the Mandatory Disclosure Act are suggested.

Another gap in the Mandatory Disclosures Act is that it covers only residential real property with one to four dwelling units or a condominium or cooperative apartment, the primary use of which is occupancy as a residence.[158] Empty lots with no structures on them are not covered, even though the lot may have a history of flooding and erosion. By

[153] Haw. Rev. Stat. § 508D
[154] Haw. Rev. Stat. § 508D-15(a)(1)
[155] Haw. Rev. Stat. § 508D-15(a)(4)
[156] Shaffer v. Earl Thacker Co., 6 Haw. App. 188, 716 P.2d 163 (1986).
[157] County of Hawaii v. Sotomura, 54 Haw. 176 (1973).
[158] Haw. Rev. Stat. § 508D-1

requiring disclosure of known risks for empty lots, the issue of hazard mitigation can be addressed one or two rungs higher in the development hierarchy (Figure 2-2). For example, if hazard disclosure is required at Stage 6, when empty lots are sold, it would provide a powerful incentive for the landowner to subdivide at Stage 4 with hazard mitigation measures in mind. This issue can be addressed in the Mandatory Disclosures Act, but a more appropriate law to address the issue may be in the Uniform Land Sales Practices Act.

10.2 Uniform Land Sales Practices Act

The Uniform Land Sales Practices Act ("Land Sales Act") was passed in Hawaii in 1967 and deals specifically with the sale of lands that are subdivided.[159] Under this Act, a public offering statement is to be delivered to all purchasers and prospective purchasers of a lot in a subdivision.[160] The public offering statement is to fully and accurately disclose the physical characteristics of the subdivided lands offered and all unusual or material circumstances or features affecting the subdivided lands.[161]

Required information in the public offering statement that is relevant to hazard mitigation includes:

1. Existing zoning regulations, including land use classifications and general plan;

2. Encumbrances, easements, liens, restrictions;

3. Elevation of the land;

4. Soil conditions – drainage; and

5. Exposure to natural hazards; e.g., earthquakes, floods, tidal waves, volcano, forest fires, slides, etc.[162]

Based on the above provisions, it would be appropriate (and should be expected) that any lots with a history of erosion would be fully disclosed along with any county policy against hardening of the shoreline with seawalls and revetments. If a landowner knows there is a disclosure requirement for erosion, or any policy against hardening of the shoreline, the tendency would be to make a greater effort to plan for this hazard when lots are created in the subdivision process (Chapter 8).

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[159] Haw. Rev. Stat. § 484
[160] Haw. Admin. Rules § 16-104-26(a)
[161] Haw. Admin. Rules § 16-104-2
[162] Haw. Admin. Rules § 16-104-25

The rules for Hawaii's Land Sales Act can be improved in several respects. First, the reference to tidal waves can be replaced with the term tsunamis to more clearly reflect the current terminology for this natural hazard.

Another improvement is that erosion should be expressly named in the listing of the natural hazards to be disclosed for the reasons discussed previously. It is important to list erosion, bluff erosion and lava, because proper planning requires that these hazards be addressed during the siting stages of development (Table 3-1).

Probably the greatest weakness in the Land Sales Act is that there is an exemption from the requirement for a public offering statement if fewer than 20 lots are offered by a person in a year.[163] Therefore, there would be no disclosure requirement for small subdivisions.

10.3 Interstate Land Sales Full Disclosure Act

Aside from compliance with the State Land Sales Act, there is the requirement to comply with the Federal Interstate Land Sales Full Disclosure Act ("ILSFDA").[164] The ILSFDA has many similarities to the State Land Sales Act in that a property must be registered and disclosure statements or reports generated. The property report requires disclosure if the landowner has a program to provide, at least minimum controls for soil erosion and flooding.[165] The report also requires disclosure if the area is subject to natural hazards or has been formally identified by any federal, State or local agency as an area subject to the frequent occurrence of natural hazards (e.g., tornadoes, hurricanes, earthquakes, mudslides, flash flooding, etc.).[166]

The requirements of the ILSFA are subject to more exemptions than in the State Land Sales Act. For instance, there are exemptions for: (i) improved lots that have a residential or commercial building, (ii) the sale or lease of lots to parties intending to construct residential or commercial structures for resale or re-lease, or (iii) the sale or lease of real estate zoned for commercial and industrial use. Most importantly, there is an exemption for subdivisions that have less than 25 lots (compared to 20 lots for Hawaii's Land Sales Act).

10.4 Role of Hawaii State Legislature

The State legislature should consider if the Mandatory Disclosures Act or the Land Sales Act should be amended to strengthen notification of hazards to prospective purchasers.

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[163] Haw. Rev. Stat. § 484-3(a)(1)
[164] Interstate Land Sales Full Disclosure Act, 15 U.S.C. §§ 1701 – get USC
[165] 24 Code of Federal Regulations § 1710.115(e)
[166] 24 Code of Federal Regulations § 1710.115(g)

For the Mandatory Disclosures Act, changes can be made to list all natural hazards, in particular erosion, bluff erosion and lava as material facts that require disclosure. It would also be important to disclose any county policies which would be relevant to mitigation measures such as shoreline hardening.

Under the Land Sales Act, the Legislature and the Department of Commerce and Consumer Affairs ("DCCA") should consider changes in the law for smaller subdivisions. For a small subdivision (i.e., less than 20 lots), the protection offered to the consumer from disclosure of natural hazards may outweigh the burden of producing a public offering statement. From conversations with the DCCA, the public offering statement and registering of the subdivision should take less than six months. The time and money involved in processing is tied to subdivision size. Therefore, changing the Act to eliminate the exemption for small subdivisions should not be overly burdensome.

10.5 Role of Planning Departments

There are many opportunities for county planning agencies to insure that prospective purchasers of coastal lots are fully informed of material facts. For example, the subdivision regulations for Honolulu require that the subdivider notify future homeowners that the agency is not responsible for any repair or maintenance of private improvements.[167] The Hawaii County General Plan recommends that full disclosure of potential hazards from lava flows and volcanic emissions be provided to prospective purchasers of homes or other real estate.

The county planning agencies should monitor amendments of the Mandatory Disclosures Act or the Land Sales Act by the legislature to strengthen disclosure of natural hazards. Even without the amendments, conditions for land use approvals granted by the county can include proper disclosure of hazard risks to prospective purchasers. By educating the buyer, economic incentives are created for the seller to build stronger and locate safer. Structures that have the proper mitigation built into the design will be more valuable than seemingly larger, more elaborate designs without the necessary safeguards.

This manual recommends that all potential hazards that could affect a property should be disclosed -- unless those hazards are general to every property in the state, e.g., hurricane wind damage. Accordingly, there should be adequate disclosure of flooding, wave action, erosion, bluff erosion, tsunami, lava and earthquake risks. In the case of hurricanes, disclosure should not be required unless there is a past incident of damage to the structure.

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[167] Subdivision Rules and Regulations of the City and County of Honolulu § 5-503

10.6 Role of the Purchaser

Regardless of whether the State legislature or county planning departments take action to strengthen real estate disclosure requirements, buyers should take steps to protect themselves by conducting the proper due diligence related to coastal hazards before buying a house or an empty lot. Due diligence investigation by the buyer is standard for any real estate transaction. In the case of purchase of coastal lots, the risks of coastal hazards should be a part of the buyer's investigation.

Although consumer protection laws partly relieve the buyer's duty to make independent inquiry into the condition of the property, the gaps identified in this Chapter still make necessary active inquiry by the purchaser. Furthermore, while disclosure laws require a seller to inform the buyer of all material facts that are known, there is no duty for the seller to investigate the extent or degree of those problems.

10.6.1 Real Estate Brochure

A real estate brochure is an effective means to alert potential buyers on what to look for in a coastal property in order to avoid erosion, wave and flood hazards. The brochure should cover coastal processes, potential hazards, risk levels and steps homeowners can take to protect themselves. Identifying an erosion problem before property is purchased should be a key feature of such a brochure.

10.7 Role of Developer/Landowner

The development industry consists of many companies, large and small with diverse personalities and histories. With development along the coast under increased scrutiny, it is important that the proponent of any project be responsible and proactive in addressing potential problems. Developments should be planned to consider all coastal hazards, such as erosion, flooding, or wave inundation. These issues should be addressed, regardless of the existing regulatory framework, or the hazard risks will be passed to future homeowners who may not have the resources to adequately mitigate the problem. By being proactive in building safer, stronger and in an environmentally acceptable manner, the company can enhance its reputation of being a responsible corporate citizen.

Recommendations for Disclosure of Hazard Risks

- The Legislature should consider changes to the Mandatory Seller Disclosures in Real Estate Transactions Act to require disclosure regarding exposure to erosion, bluff erosion, and lava as well as disclosure of any county policy against hardening of the shoreline for new structures as a material fact.

- The Legislature or Department of Commerce and Consumer Affairs should consider changes to the Uniform Land Sales Act to require a public offering statement for small subdivisions (less than 20 acres) along the coast in order to notify potential purchasers of the risks of natural hazards.

- County planning departments should continuously evaluate the status of State laws regarding the disclosure of hazard risks. Any gaps can be compensated for by requiring disclosure to prospective purchasers as a condition for a land use approval. The disclosure would be for any erosion or hazard risks (e.g., intentionally building in an erosion zone) and for any county policy regarding hazard mitigation (e.g., policy against shoreline hardening).

- The landowner should properly design lots and structures for natural hazards. Along with disclosing the risks of coastal hazards, the benefits of the enhanced design can be marketed.

- The prospective purchaser of real estate (empty lots or lots with a residence) should fully investigate the physical condition of the site to assess the risks of erosion and other natural hazards. Due diligence should not be compromised by belief that consumer protection laws will address all risks or issues. Generally, consumer protection laws do not place a duty on the seller to investigate problems, only a duty to disclose what is material and known.

- Due diligence by the prospective purchaser may include: (1) review of existing reports on erosion and coastal hazards (Appendix A), (2) hiring a consultant (Appendix B), (3) review of the report "Natural Hazards in the Hawaiian Coastal Zone," (Fletcher, et al., 2002), (4) a site visit to check for evidence of erosion or other hazards, (5) specific questions that are posed to the seller of the property or to the neighbors and (6) specific requests for information on the physical condition of the property.

- Produce a real estate brochure to inform potential purchasers of the risks of coastal hazards and how to identify those risks.

Figure 10-1 – Disclosure of Hazard Risks During Property Transfer - Summary of recommendations regarding disclosure to prospective purchasers during the lot transfer stage of development.

erosion rate, existing data can be used if it is of sufficient quality and vintage. Alternatively, a consultant can be hired by the lot owner to conduct an erosion study using the minimum standards provided in Chapter 4. While there could be concerns about the cost of an erosion study, it would be a fraction of the cost if the homeowner needed to respond after it is discovered that construction proceeded in an erosion zone. Furthermore, the erosion study may be needed to determine the risks of flooding (Figure 1-9 & Section 4.4). Flooding regulations play an important part in construction methods.

For cases where the existing lot geometry would not accommodate the technically based setback, or there is an undue burden on the lot owner, a minimum buildable area should be set that will always insure there is a some economically viable use and prevent a regulatory takings issue (see Appendix D – Regulatory Takings). If a minimum buildable area is structured properly, it will facilitate the implementation of scientifically based shoreline setback standards even for infill lots.

Chapter 11 - Home Construction (Stage 7)

The home construction stage presents one of the greatest challenges to coastal planners. As shown in Figure 2-5, landowners at this stage of development are likely to have the highest investment-backed expectations since they have either gone through numerous development stages, or they have bought improved lots that have gone through numerous development stages. In either situation, there is a built up and reasonable expectation that construction can proceed in a certain manner. That expectation may be further supported by a relatively high market value of the property.

In contrast, the agencies have police power to regulate for the health, safety and welfare of the public. The extent of that power is dependant on the government purpose for the regulation. The government will have strong power to regulate environmental matters, and even greater power for issues related to hazard mitigation.

The investment-backed expectations of the landowner versus the duty and authority of an agency to mitigate for coastal hazards come into play when it is time to site a new structure on the lot. Siting issues may be addressed during application for a Special Management Area Permit ("SMA"). Conversely, the numerous issues to address with regard to proper construction techniques are raised at the time a building permit is sought.

11.1 Siting a New Home on Infill Lots

There are numerous vacant lots along the shoreline in the State that are for sale and ready to be built on (Figures 2-4 and 11-1).

Figure 11-1 - Empty Lot at Lanikai Beach, Oahu – Example of numerous infill lots around the State that have been subdivided, improved and are ready for home construction.

accounts for investment-backed expectations of the landowner. The formulation is also weighted to give priority to protecting inhabitants and the environment since an increase in the original lot size leads to a larger buildable footprint, but a smaller percentage of the lot that a structure can occupy. In summary, the formulation accounts for technical, legal and fairness issues for the one stage in the development hierarchy that is the most difficult to implement for the siting of new structures (Figures 2-5 & 2-6).

Both Maui's minimum buildable depth of 35 feet and the use of a sliding scale for minimum buildable area based on original lot size have advantages and disadvantages. The minimum buildable depth is stricter for large lots while being more protective of inhabitants and the environment. It does not factor, in a comprehensive manner, the investment-backed expectations of the landowner and therefore, may be more difficult to pass politically. Difficulty in passage may prevent implementation of a 70-40 setback. In addition, the minimum buildable depth may actually be less protective for small lots, since it allows a larger structure to be built on a 6,000 square foot lot (2,800 vs. 2,400 square feet). Counties can weigh the pros and cons of the two different formulations and decide which option may be more appropriate. These examples are provided to show that even at the infill lot stage, it is possible to implement scientifically-based standards that reduce the risks of hazards, while accounting for reasonable landowner concerns.

If the minimum lot size provisions are implemented, Maui requires that: (i) an indemnification be given to the agencies for the landowner intentionally building in an erosion or hazard zone, (ii) structures in the erosion zone are elevated above the base flood elevation, and (iii) there be a prohibition against erosion-control or shoreline hardening structures or activities with the exception of beach replenishment (Chapter 12) or dune nourishment activities (Chapter 10). A prohibition against shoreline hardening would encourage proper siting of new coastal development through the increased reliance on safety setbacks.

The steps taken by Maui are useful hazard mitigation strategies. In addition, the following suggestions are offered for consideration. First, if the minimum buildable area is triggered, the structure should be built as far inland as possible. Second, there could be a disclosure requirement for all sales to prospective purchasers that construction proceeded in an erosion zone, that the county has implemented a no shoreline hardening provision for new structures and there is an indemnification running from the original homeowner to the county. Finally, all of these conditions can be recorded and made to run with the land.[168] These measures would provide additional incentive to plan for coastal hazards prior to construction.

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[168] Covenants can be made to run with the land if: (1) it "touches and concerns" the land, (2) the parties intend it to run with the land, and (3) there is privity of estate (e.g., sale of original covenanting party to a successor). Waikiki Malia Hotel, Inc. v. Kinkai Properties Limited Partnership, 75 Haw. 370; 864 P.2d 1048 (1993).

Because the house is farther from the shoreline and on higher ground, it is less susceptible to erosion, wave inundation and flooding.

That erosion, wave inundation and flooding risks are reduced as a structure is placed farther from the coast and on higher ground is intuitive and represented graphically in Figures 3-1 and 3-2. Building inland will generally expose a structure to less powerful waves and lower flood levels, while providing a buffer from erosion. This reflects the fact that the wave and flood levels will diminish inland due to the rising ground elevation and friction or decay from roughness of the coastal surface. Depending on the size of a lot and the particular hazard event, the difference could be significant.

Because of the reduction in erosion, wave inundation and flood risks inland, it is recommended that structures be setback as far from the shoreline as possible on existing lots using the formula outlined in Chapter 4 (70 years times an erosion rate adjusted for errors and sea level rise plus a 40 foot buffer or "70-40"). In order to determine an

Chapter 11 - Home Construction (Stage 7)

The home construction stage presents one of the greatest challenges to coastal planners. As shown in Figure 2-5, landowners at this stage of development are likely to have the highest investment-backed expectations since they have either gone through numerous development stages, or they have bought improved lots that have gone through numerous development stages. In either situation, there is a built up and reasonable expectation that construction can proceed in a certain manner. That expectation may be further supported by a relatively high market value of the property.

In contrast, the agencies have police power to regulate for the health, safety and welfare of the public. The extent of that power is dependant on the government purpose for the regulation. The government will have strong power to regulate environmental matters, and even greater power for issues related to hazard mitigation.

The investment-backed expectations of the landowner versus the duty and authority of an agency to mitigate for coastal hazards come into play when it is time to site a new structure on the lot. Siting issues may be addressed during application for a Special Management Area Permit ("SMA"). Conversely, the numerous issues to address with regard to proper construction techniques are raised at the time a building permit is sought.

11.1 Siting a New Home on Infill Lots

There are numerous vacant lots along the shoreline in the State that are for sale and ready to be built on (Figures 2-4 and 11-1).

Figure 11-1 - Empty Lot at Lanikai Beach, Oahu – Example of numerous infill lots around the State that have been subdivided, improved and are ready for home construction.

The critical siting issue with infill lots is to determine how far inland the structures should be set back. Should the structures be closer to the shoreline, as some, but not all homeowners would prefer (Figure 11-2). Alternatively, the structures can be built as far inland as possible (closer to the road). This would be preferable from an environmental, hazard mitigation and for some homeowners, a utility standpoint.

Figure 11-2 – Keawakapu Beach, Maui – Three houses with different shoreline setbacks. The house on the right is about 50 feet from the shoreline, the middle house is between 50 to 100 feet away and the house on the left, over 100 feet from the shoreline. The house on the right has a large frontyard but small backyard. The house on the left has a small frontyard and a large backyard. Because the house is farther from the shoreline and on higher ground, it is less susceptible to erosion, wave inundation and flooding.

That erosion, wave inundation and flooding risks are reduced as a structure is placed farther from the coast and on higher ground is intuitive and represented graphically in Figures 3-1 and 3-2. Building inland will generally expose a structure to less powerful waves and lower flood levels, while providing a buffer from erosion. This reflects the fact that the wave and flood levels will diminish inland due to the rising ground elevation and friction or decay from roughness of the coastal surface. Depending on the size of a lot and the particular hazard event, the difference could be significant.

Because of the reduction in erosion, wave inundation and flood risks inland, it is recommended that structures be setback as far from the shoreline as possible on existing lots using the formula outlined in Chapter 4 (70 years times an erosion rate adjusted for errors and sea level rise plus a 40 foot buffer or "70-40"). In order to determine an erosion rate, existing data can be used if it is of sufficient quality and vintage. Alternatively, a consultant can be hired by the lot owner to conduct an erosion study using the minimum standards provided in Chapter 4. While there could be concerns about the cost of an erosion study, it would be a fraction of the cost if the homeowner needed to respond after it is discovered that construction proceeded in an erosion zone. Furthermore, the erosion study may be needed to determine the risks of flooding (Figure 1-9 & Section 4.4). Flooding regulations play an important part in construction methods.

For cases where the existing lot geometry would not accommodate the technically based setback, or there is an undue burden on the lot owner, a minimum buildable area should be set that will always insure there is a some economically viable use and prevent a regulatory takings issue (see Appendix D – Regulatory Takings). If a minimum buildable area is structured properly, it will facilitate the implementation of scientifically based shoreline setback standards even for infill lots.

For example, in Maui's new shoreline setback rules (see Section 4.1.8), a minimum buildable lot depth helped to address concerns over small lots. The rules called for a minimum buildable lot depth (perpendicular to the shore) of 35 feet, regardless of lot size. For a hypothetical lot width (parallel to the shore) of 100 feet and 10 foot side setbacks, this would allow for a house with a footprint of 2,800 square feet ((100 - 10 - 10) x 35).

While this is a substantial structure, another alternative that appears to be fairer is to tie the minimum buildable area with the original lot size. This will ensure that landowner A with an original lot size of 20,000 square feet and landowner B with an original lot size of 6,000 square feet do not both wind up with a minimum buildable area of 2,800 square feet. In the case of A, only 14% of the land could be used, while for B, 47% of the land could be used.

The increase of minimum buildable area with original lot size need not be linear (i.e., the same percentage ratio). The ratio can change to do the following: (i) be protective of future inhabitants, (ii) be protective of the coastal area, (iii) ensure the landowner is able to build a substantial structure, (iv) consider investment backed expectations of the landowner and, (v) give priority to protection of occupants and the coastal environment over building a luxury castle along the coast. As an example, the minimum buildable area could be 40% of original lot size for a 6,000 square foot lot (2,400 square feet), 35% for an original lot size of 10,000 square feet (3,500 square feet), and 30% for an original lot size of 15,000 square feet (4,500 square feet).

The above percentages can be adjusted to match the needs of the counties. This formulation will allow implementation of technically based standards such as a (70-40) when the lots are large enough. When the lots are too small, the minimum buildable area allows economically viable use, while the sliding scale for the minimum buildable area accounts for investment-backed expectations of the landowner. The formulation is also weighted to give priority to protecting inhabitants and the environment since an increase in the original lot size leads to a larger buildable footprint, but a smaller percentage of the lot that a structure can occupy. In summary, the formulation accounts for technical, legal and fairness issues for the one stage in the development hierarchy that is the most difficult to implement for the siting of new structures (Figures 2-5 & 2-6).

Both Maui's minimum buildable depth of 35 feet and the use of a sliding scale for minimum buildable area based on original lot size have advantages and disadvantages. The minimum buildable depth is stricter for large lots while being more protective of inhabitants and the environment. It does not factor, in a comprehensive manner, the investment-backed expectations of the landowner and therefore, may be more difficult to pass politically. Difficulty in passage may prevent implementation of a 70-40 setback. In addition, the minimum buildable depth may actually be less protective for small lots, since it allows a larger structure to be built on a 6,000 square foot lot (2,800 vs. 2,400 square feet). Counties can weigh the pros and cons of the two different formulations and decide which option may be more appropriate. These examples are provided to show that even at the infill lot stage, it is possible to implement scientifically-based standards that reduce the risks of hazards, while accounting for reasonable landowner concerns.

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The steps taken by Maui are useful hazard mitigation strategies. In addition, the following suggestions are offered for consideration. First, if the minimum buildable area is triggered, the structure should be built as far inland as possible. Second, there could be a disclosure requirement for all sales to prospective purchasers that construction proceeded in an erosion zone, that the county has implemented a no shoreline hardening provision for new structures and there is an indemnification running from the original homeowner to the county. Finally, all of these conditions can be recorded and made to run with the land.[168] These measures would provide additional incentive to plan for coastal hazards prior to construction.

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[168] Covenants can be made to run with the land if: (1) it "touches and concerns" the land, (2) the parties intend it to run with the land, and (3) there is privity of estate (e.g., sale of original covenanting party to a successor). Waikiki Malia Hotel, Inc. v. Kinkai Properties Limited Partnership, 75 Haw. 370; 864 P.2d 1048 (1993).

11.2 The Erosion Study

The building of a house on an empty lot is usually a ministerial administrative action, that is, if the applicant follows the building codes, then a permit is likely to be issued. Nevertheless, the counties can generally request other information in the application for a building permit.[169]

Maui County requires conformance with the policies and objectives of the general plan or the provisions of the community plan – even for a building permit.[170] If plans contain provisions for hazard mitigation, then these specific issues can also be considered during the construction of a home.

From a practical point of view, it may be difficult to ask the owner of a single lot to conduct a hazard assessment before building on the lot. However, with information from the lots that are already developed, the counties should have an idea of the hazards that are likely in the area. For this reason, this manual only recommends that the applicant on an infill lot conduct an erosion study on sandy shorelines. An erosion study conducted before placement of the house can help with the siting of the house on the lot and reduce the risks from erosion, wave inundation and flooding. The study would not be needed if there is pre-existing data of sufficient quality and vintage.

The authority to ask for an erosion study may come from: (1) building permit provisions that give the agencies authority to ask for more information, (2) standards for approval for a Special Management Area permit, or (3) requirements under the National Flood Insurance Program that require structures to be sited reasonably safe from flooding risks. Since erosion may increase flood risks, the erosion study would be needed to determine the impact on the risk of flooding.

11.3 Amendment to Shoreline Setback Regulations

For the most part, the measures in this manual can be implemented within the existing authority of State and county regulations. Even at the infill lot stage (stage 7), the counties could request an erosion study and a safety buffer under the discretionary authority they have to evaluate a Special Management Area ("SMA") permit. An SMA is not normally required for construction of a single family house that is not part of a larger development. However, if the agency determines that a structure would have a cumulative impact, or has a significant environmental or ecological effect on the Special Management Area, then it could be considered a "development" and an SMA permit would be required.[171]

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[169] Maui Comprehensive Zoning Ordinance § 19.500.050 and 19.510.010(D)(25)
[170] Maui Comprehensive Zoning Ordinance § 19.510.010(D)
[171] Haw. Rev. Stat. § 205A-22

An alternative would be to amend the shoreline setback rules for the individual counties. The advantage of amending the rules is that it provides definite notice to landowners of new setback requirements. The requirement to conduct an erosion study and provide an extended setback could be specified in the rules and there would be no claim that the requirement is ambiguous or arbitrary.

At the infill lot stage, a county should consider whether to amend their setback regulations for this stage of development. If the setback regulations are amended, minimum lot provisions should be included to deal with fairness issues for small lots (Section 11.1). In addition, the issue of nonconforming structures should be addressed.

11.3.1 Nonconforming Structures

Nonconforming structures are existing structures that once complied with land use and construction standards, but due to later amendments or new rules, are no longer in conformance. These structures have been the subject of much controversy during proposed amendments to shoreline setback rules and that conflict can block the establishment of safety standards for new structures. This should not be the case with proper planning of the nonconforming structure issue.

In the passage of Maui's new shoreline setback regulations, the issue of rebuilding damaged nonconforming structures was the major concern for those homeowners that testified against the rules. Homeowners expressed concern that an increased shoreline setback would prevent them from rebuilding if their house was destroyed by non-hazardous (e.g., fire) or hazardous causes (e.g., hurricane, storm, wave or erosion).

In developing options for nonconforming structures, it is recognized that a family living in an existing structure is more emotionally and financially attached to the property than a landowner proposing a new structure on an empty lot. Thus, the two situations should be treated differently, or the passage of appropriate scientifically based setback rules could be made significantly more difficult. This is consistent with the overall strategy in this manual, to design mitigation measures that are fair and appropriate, given the situation of the parties at that particular stage of development (Figures 2-5 and 2-6).

Ideally, the issue of building new structures on existing lots should be addressed in this Chapter (Section 11.1), while the issue of rebuilding damaged nonconforming structures is more appropriately addressed in Chapter 12 – Erosion/Hazard Noticed – Remedial Options Evaluated (Stage 8). Nevertheless, they are both covered in this Chapter because the issues are intimately related and both are likely to be raised in the passage of any shoreline setback regulations.

Five options are presented that the counties can consider to address nonconforming structures:

1. **Percent Damage Threshold** - The counties can treat nonconforming structures in the traditional manner. For example, under the National Flood Insurance Program, if a nonconforming structure is damaged or destroyed and needs repair greater than 50% of its original value, then the new flood construction standards are required to be followed. The percent threshold provision is a common method to implement new safety construction standards into older structures. This strategy is protective but rigid. Passage of setback rules under this scheme may be difficult since this would require the retroactive application of siting standards, as opposed to construction standards. Siting standards may be more difficult to implement if the lots are not sufficiently large.

2. **Fire Exemption** - It is also common that an exemption to a new shoreline setback requirement be obtained for existing structures destroyed by fire or other non-hazardous causes. The exemption may be justified since shoreline setbacks are designed to protect against coastal hazards. Existing homeowners can assert that they should not be penalized by hazard mitigation measures for property damage unrelated to a natural hazard. Maui's new shoreline setback rules provide an exemption for fire. This exemption was instrumental in relieving the concerns of some, but not all homeowners.

3. **Hardship Variances** – It is common to treat new and existing structures the same, but rely on a system of variances to evaluate on a case by case basis the legitimacy of reconstructing damaged nonconforming structures in the setback area. Such a scheme is flexible, but provides uncertainty to property owners without the establishment of what criteria are used to recognize hardship. This provision is in Maui's shoreline setback regulations and also helped to alleviate some, but not all of the homeowner's concerns.

4. **Different Minimum Buildable Area Standards** - New structures on infill lots and damaged nonconforming structures could be subject to the same setback rules but with different minimum buildable area standards. For instance, the minimum buildable area for a new structure on an infill lot can be tied to the original lot size and based on a 40%, 35% and 30% ratio (See Section 11.1). The minimum buildable area for a nonconforming structure destroyed by fire or other means could be tied to original lot size with different percentages, e.g., 45%, 40%, 35%. This would reflect the greater attachment that existing homeowners have for their property. The percentages could be adjusted to reflect the needs for each county. Different minimum buildable areas for new or existing structures could also be set that are not tied to original lot size.

5. **<u>Existing Structure Status</u>** – It is also possible to sever the treatment of new and existing structures by simply requiring the safety setback for new structures. If an existing structure were damaged or destroyed, the homeowner would simply be given existing structure status, allowing the person to rebuild in the same location with no increase in the building footprint. Counties can encourage rebuilding of damaged structures further inland by numerous incentives such as trading a streamlined permit or an increased buildable area for an increased shoreline setback using specified standards. Open space incentives can be crafted using height, street and side setback variances. This option, while not as protective as option 1, is more flexible and accounts for the varying positions of different parties. Furthermore, it may allow implementation of technically based setbacks such as a (70-40).

All of the above options employ strategies and tools commonly utilized in the land use and construction fields. There are also numerous permutations and combinations of the above options. It is up to the county to decide what is the most appropriate variation, given the political climate, and craft setback rules that are both protective and fair. The key point is that the issue of damaged nonconforming structures should not interfere with the need to implement technically based safety setbacks for new structures.

Table 11-1 summarizes the discussion of options for shoreline setback regulations at the infill lot stage. The table addresses issues for both new structures as well as for damaged nonconforming structures. An additional option is included to address implementing shoreline setbacks through the SMA process, as discussed in Section 11.3.

Options	Pros	Cons	Comments
SMA Process – No amendment to shoreline setback regulations – Address through SMA permit.	No new regulations – Use existing authority - Can address setback for new structures or damaged existing structures.	May be challenged as arbitrary – Possible lack of notice to landowner.	Option for counties. Proper outreach suggested to provide criteria and guidance for cumulative or environmental impact.
Percent Damage Threshold - Amend shoreline regulations with setback for the erosion zone. Setback applies to structures damaged greater than 50% of original value.	Landowner notice - Agency consistency - Standard applies to new and existing structures.	New regulations - Nonconforming structures - Rigid scheme - Controversy for existing structures.	Common option - Fails to consider the emotional attachment of current homeowners - Difficult to pass.
Fire Exemption - Amend regulations with setback for erosion zone - Exempt for nonconforming structures destroyed by fire or non-hazard related causes.	Common exemption – Easier to pass than percent damage option. Partially addresses financial and emotional attachment of homeowner to the property.	New regulation - Does not convert nonconforming structures destroyed by fire to safer standard.	This concept used by Maui in new shoreline setback rules. By itself, harder to pass than minimum buildable area or existing structure status option.
Hardship Variances New shoreline setback regulations with damaged nonconforming structures addressed by variances.	Common provision – Flexibility provided as facts for each case evaluated.	Uncertainty as to application of the variance creates much concern for homeowners.	In Maui's new shoreline setback regulations. Uncertainty generates concern. Provide hardship guidelines.
Different Minimum Buildable Area Standards - Same setback rule for new and damaged nonconforming structures. Apply different minimum buildable areas tied to original lot size for new & existing structures.	Differentiates between new and existing structures and between small and large lot sizes. A fair formulation.	Complicated but valid option. New or amended regulation.	Great flexibility provided in adjusting percentages of the buildable area to fit county needs. Another option - do not tie different minimum buildable areas to original lot size.
Existing Structure Status - Amend regulations with setback for erosion zone - Applies only to new structures - Existing structure exemption.	Easiest to pass – More protective than current regulatory practice - Addresses new structures - Existing structures can be addressed by regulatory or open space incentives.	New regulation but easiest to pass - By itself, doesn't address existing structures.	Valid option - Flexible – Incentives such as increased buildable area for increased setback can mitigate lack of setback requirement for existing structures.

Table 11-1 – Alternatives Discussed for Shoreline Setback Requirements at the Infill Lot Stage.

11.4 Construction Issues at the Infill Lot Stage

Up to this point, this manual has concentrated on siting structures to mitigate the risks of coastal hazards. The remainder of this Chapter covers the equally important issue of building correctly, or construction issues.

Siting issues during the infill lot stage of development can generally be addressed when a Special Management Area permit is obtained. Conversely, construction issues are addressed when a building permit is applied for and obtained from the respective building departments for each county (Table 2-1).

For references on construction to mitigate the risks of coastal hazards, the reader is referred to the following resources: (1) the Federal Emergency Management Agency's Coastal Construction Manual, in particular Chapters 9 through 14, (2) the relevant building codes for each county,[172] (3) the building departments for each county (Table 2-1 – row on home construction), (4) the FIRM maps for each coastal area, located at the respective county agency that issues building construction permits (Table 2-1), (5) the report Atlas of Natural Hazards in the Hawaiian Coastal Zone (Fletcher, et al., 2002) and the (6) the flood regulations for each county (see Table 11-2).

11.4.1 National Flood Insurance Program

The National Flood Insurance Program is administered by the Federal Emergency Management Agency. Under this program, federal insurance to protect against flooding is provided if a community adopts standards for construction that will mitigate the damage from flooding. Minimum construction standards are established for the Special Flood Hazard Area, which is the area subject to flooding from the 100-year base flood. The 100-year base flood is the flood event that has a 1% chance of occurring every year.

In general, all buildings in the Special Flood Hazard Area ("SFHA") are to meet the following requirements: (1) be sited reasonably safe from flooding, (2) be designed to prevent floatation, collapse, and lateral movement during flooding, (3) be made of flood-resistant materials, (4) be constructed to minimize flood damage and (5) have HVAC/plumbing designed or located to prevent water entry.

There are additional standards for construction in the SHFA, depending on what flood district the building is located. Minimum requirements for construction in the V zone and A Zone are depicted in Figures 11-3 and 11-4, respectively.

[172] As discussed in Chapter 4, the City and County of Honolulu, Kauai and Maui follow the 1997 UBC, while Hawaii follows the 1991 UBC. Each county has amended certain provisions of the UBC and the county ordinances. The county building departments should be checked for changes to applicable building codes or amendments.

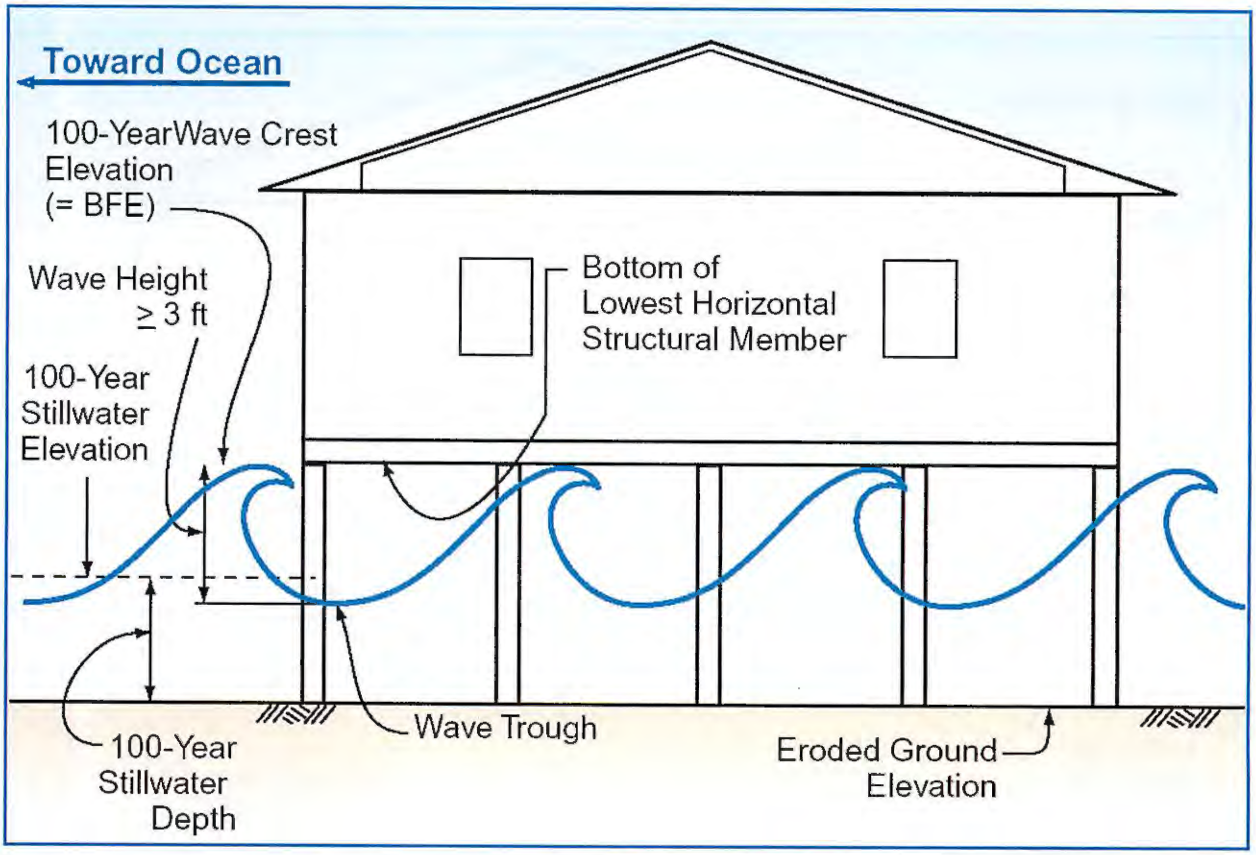


Figure 11-3 – Minimum NFIP requirements for the V zone (From FEMA CCM, 2000). Under the National Flood Insurance Program, structures in the V zone must have the bottom of the lowest horizontal structural member elevated on pilings, post, columns or piers above the Base Flood Elevation (see Figure 2-7). The FEMA CCM recommends that the lowest structural member be elevated an additional distance above the BFE (adding freeboard) to create an extra margin of safety. By slightly exceeding the design flood elevation, major damage can be avoided. For most coastal states, the V zone is determined where the wave height is greater than 3 feet over the 100-year stillwater elevation. In Hawaii, the V zone is determined where the depth of water from the 100-year flood is greater than 4 feet (See Section 4.2).

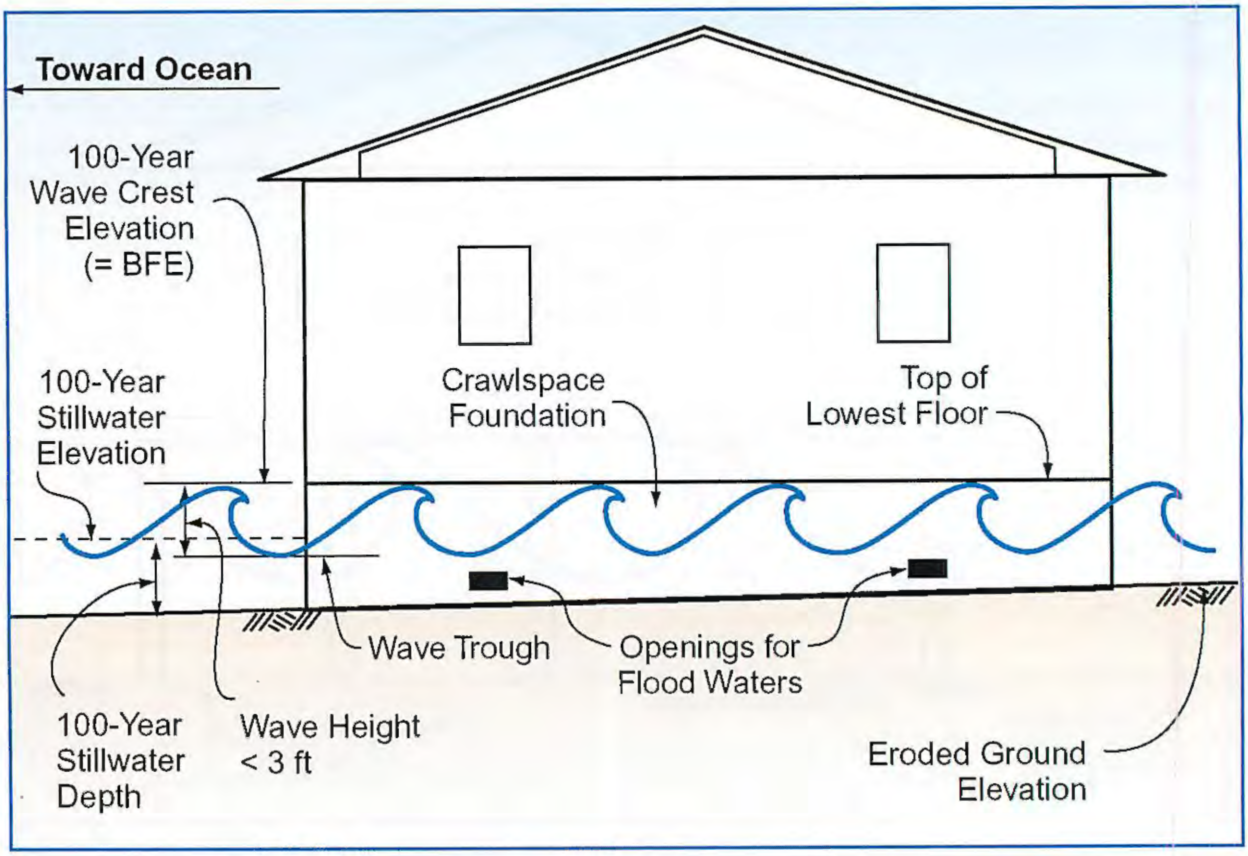


Figure 11-4 – Minimum NFIP requirements for the A Zone (From FEMA, CCM, 2000). Under the National Flood Insurance Program, structures in the A zone must be elevated above the Base Flood Elevation and supporting walls must have openings to allow entry and exit of flood waters. Many coastal states define the A zone where wave height over the 100-year stillwater elevation is less than 3 feet. In Hawaii, the A zone is determined where the water depth from the 100-year flood event is less than 4 feet. Boundaries for the A zone are found in the FIRMs that are available at the building departments for each county.

The standards for construction in the NFIP apply to new construction, structures which are substantially damaged (greater than 50% damage), structures undergoing substantial improvement, new subdivisions and new or replacement water supply or sewer systems.

The standards for construction are summarized in Table 11-2. This Table compares key portions of the Federal and local flood regulations with the FEMA CCM and this manual. The Table is not a comprehensive summary of each law. The reader should refer to the specific cites in the Table to identify the requirements for each county.

Table 11- 2 - Comparison of National Flood Insurance Program, Local Flood Standards, FEMA CCM and this Guidebook

Issue	NFIP	Oahu	Maui	Kauai	Hawaii	FEMA CCM	Mitigation Guidebook
Applicable Law	NFI Act of 1968 (P.L. 90-418 & 91-152), U.S. Disaster Protection Act of 1973 (P. L. 93-234).	Land Use Ordinance - City & County of Honolulu – Art. 9	Maui Comp. Zoning Ordinance Chapter 19.62	Kauai County Code – Chapter 15	Hawaii County Code - Chapter 27	Guidance – not mandatory but recommended.	Guidance – not mandatory but recommended.
V – Zone Standards (Figure 11-3)	(1) Bottom of lowest structural member of lowest floor above BFE on anchored columns or piles; (2) restrict alteration of dunes; (3) no fill for structural support; (4) space below BFE only for parking, access, storage; (5) walls not used for support.	Same as col. 2 – (1) dune alteration cannot increase flooding; (2) height limit of building increased 5 ft. & not more than 25 ft. over BFE.	Same as col. 2 – (1) dune alteration cannot increase flooding; (2) height limit of building increased 5 ft. over current zoning	Same as col. 2 - (1) dune alteration prohibited, (2) height limit of structure is BFE + 15 ft.	Same as col. 2 – (1) dune alteration cannot increase flooding, (2) no building height provision.	Add 1-2 feet of freeboard over BFE.	1st option - do not alter dunes. 2nd option - dune restoration encouraged if it reduces erosion and flooding risks. Dune size should not be diminished. Vegetation should be well established (Chapter 9 & Table 9-1).
A – Zone Standards (Figure 11-4)	(1) Elevate lowest floor above BFE; (2) Below lowest floor – (a) for parking, access, storage; (b) 2 or more wall openings 1 in^2 for every 1 ft^2 subject to flood; (c) convey entry/exit flood waters.	Same as col. 2 – (1) height limit of building increased 5 ft. & not more than 25 over BFE.	Same as col. 2 – (1) height limit of building increased 5 ft. over current zoning	Same as col. 2 – (1) height limit of structure BFE + 15 ft.	Same as col. 2 – (1) no standard for wall opening, (2) no building height provision.	Recommends treating coastal A zones as V zones.	Treat A zone areas likely to migrate into the V zone by erosion as V zones.
V – Zone Applicability	Zones VE, V1-V30, and V	Coastal High Hazard District	Coastal High Hazard V1-V30, VE or V zones.	Coastal High Hazard (tsunami) VE zones.	Coastal High Hazard (tsunami) – V, VE zones.		Wave zone (Fig. 3-1) – consider in hazard assessment construction setback for early stages of development for wave (V, VE) zones.
A – Zone Applicability	Zones AE, A1-30, AO, and A	Flood Fringe District	Special Flood Hazard Area – A, AO, A1-A30, AE, A99, AH zones	Flood Fringe – AE, AO, A1-30, AH zones & Flood Plain – A, X and D	Special Flood Hazard – A, AO, AE, A99, AH	Coastal A Zone - FEMA CCM Recommends treating coastal A zones as V zones.	Flood zone (Fig. 3-1) (A-AE-X) zones.
Erosion Zone Erosion Data	-	-	-	-	-	Needed to ascertain flood & erosion risks.	Needed to ascertain flood & erosion risks (Fig. 1-9) – create erosion zone (Fig. 3-1) – Construction setback for this zone.

11.4.2 Building Codes

The building codes for the individual counties contain the minimum construction requirements with regard to hazard mitigation. These codes apply to new construction and may apply to modifications to existing structures, or when occupancy changes.

The City and County of Honolulu, Maui and Kauai Counties follow the 1997 Uniform Building Code ("UBC"), while Hawaii County follows the 1991 UBC. The UBC contains specific design standards for flooding,[173] wind storms,[174] and earthquakes.[175] The building departments for the respective counties should be contacted to check the status of the applicable building code or any amendments.

In the discussion of flood, wind and seismic loads, the UBC is cited because with its adoption by the counties, this building code contains the minimum applicable requirements for mitigation of these hazards. Nevertheless, there is additional information on load calculation and design standards in the FEMA CCM. The FEMA CCM itself follows different standards. For example, the American Society of Civil Engineers, "Minimum Design Loads for Buildings and Other Structures" (ASCE 7) is followed by the FEMA CCM for wind loads and the International Building Code is followed by the FEMA CCM for seismic loads.

The remainder of this Chapter covers specific points with regard to the design for floods, wind storms and earthquakes. The reader is referred to Chapter 11 of the FEMA CCM for specific details regarding the loads on buildings from different natural forces, Chapter 12 for designing the building and Chapter 13 for construction of the building.

11.4.3 Water or Flood Loads

Flood loads should be determined using the methods in the applicable building codes, the counties adopted amendments or ordinances related to the building code and the FEMA CCM. Besides the issues of: (i) proper siting for flood hazard mitigation and (ii) elevation of the structures above the Base Flood Elevation (Figures 11-3 and 11-4), there is the separate issue that the supporting columns, piers, walls and structure are able to withstand the following flood loads:

- Hydrostatic loads – buoyancy or floatation affects from standing water, slowly moving water and non-breaking waves (Figure 11-5).
- Breaking Waves

[173] 1997 Uniform Building Code – Appendix Chapter 31 Special Construction – Division I – Flood Resistant Construction
[174] 1997 Uniform Building Code – Chapter 16 - Division III – Wind Design
[175] 1997 Uniform Building Code – Chapter 16 – Division III – Earthquake Design

- Hydrodynamic Forces – from rapidly moving water, including broken waves and tsunami runup (Figure 11-6); and

- Debris Impacts from waterborne objects such as logs.

The FEMA CCM also acknowledges that storm erosion, scour and long-term erosion can cause lowering of the foundation surface under foundation members resulting in the loss of load bearing capacity and resistance to lateral and vertical movements.

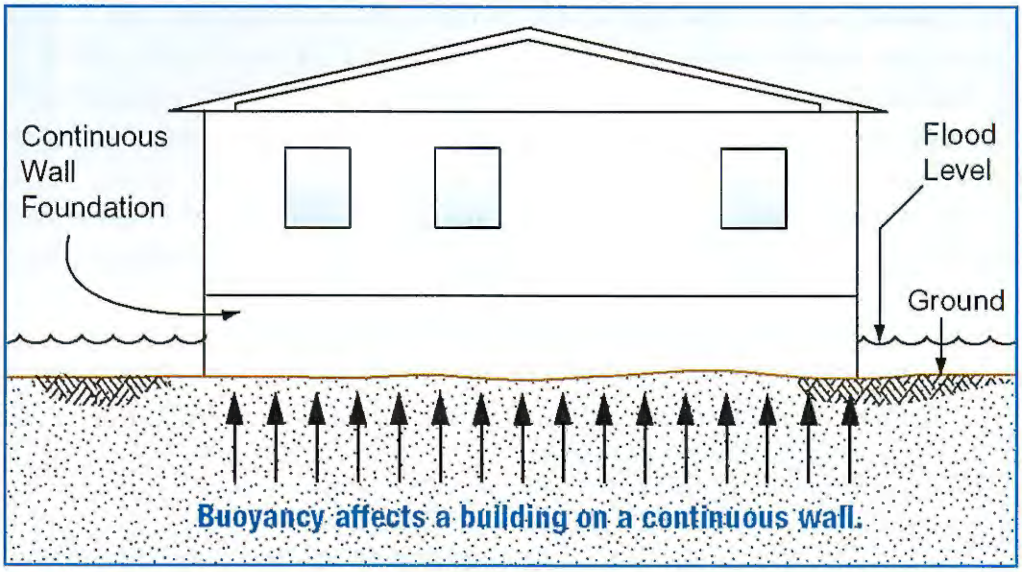
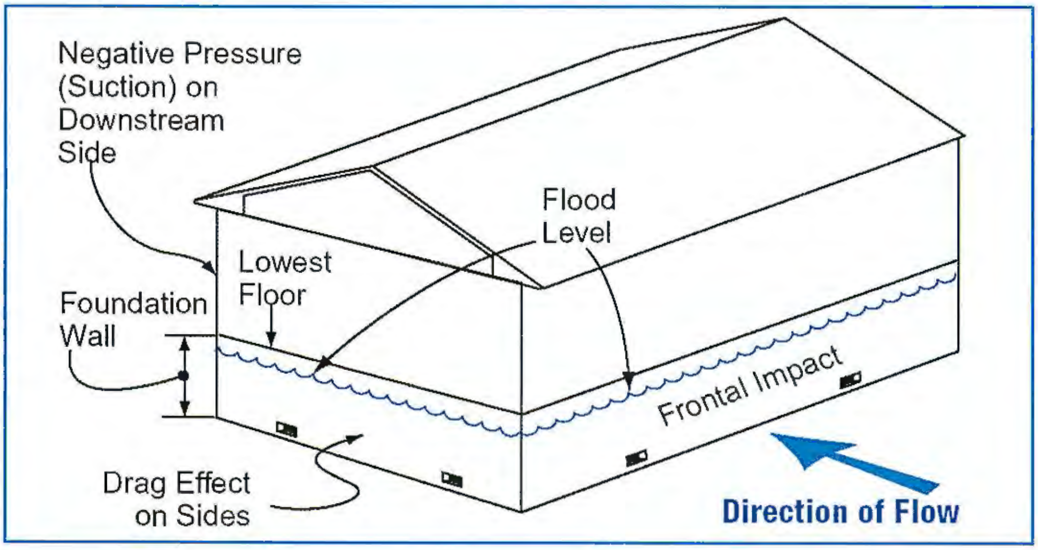


Figure 11-5 – Hydrostatic Flood Forces – Flood waters surrounding a continuous wall create buoyancy force. This is not a problem for properly designed and elevated structures above the Base Flood Elevation. From FEMA CCM, 2000.

Figure 11-6 – Hydrodynamic Forces - Moving water, breaking waves and tsunami runup exert loads on the foundation walls of the structure. From FEMA CCM, 2000.



All flood loads for a structure should be calculated including the hydrodynamic load, debris impact load on a pile, and wave impact load on a pile for structures in the V zone utilizing the formulas in Chapter 11 of the FEMA CCM. These forces are to be added together and designed for in construction. Similar calculations can be made for the flood load forces for A Zone construction (elevated on solid walls instead of pilings). Because of the greater loads on a solid wall, the FEMA CCM recommends construction in Coastal A zones be to V zone standards. The large extent of the A zones may make this FEMA recommendation overly burdensome. This manual recommends that structures in the A zone that could migrate into the V zone because of erosion be built to V zone standards.

11.4.4 Wind Loads

Wind design standards are in the applicable building codes (currently the UBC). Additional information on design can be found in the FEMA CCM, and in the ASCE 7. Although only the building codes adopted by the counties are required, consideration should be given to using measures that may be even more protective. If high resolution wind maps are available, they should be utilized in design (Section 3.5). It is recommended that county agencies continuously evaluate the adequacy of construction standards and update their requirements as amendments to the applicable building codes.

In wind design, the importance of creating a wind and rain resistant envelope is emphasized (Figure 11-7). This will protect the structure of the house, as well as prevent rain and flood damage. Glazed or laminated glass windows, shutters, plywood covers, or other devices that are impact resistant can prevent penetration of the envelope (FEMA CCM; ASCE 7; and website - www.mothernature.com).

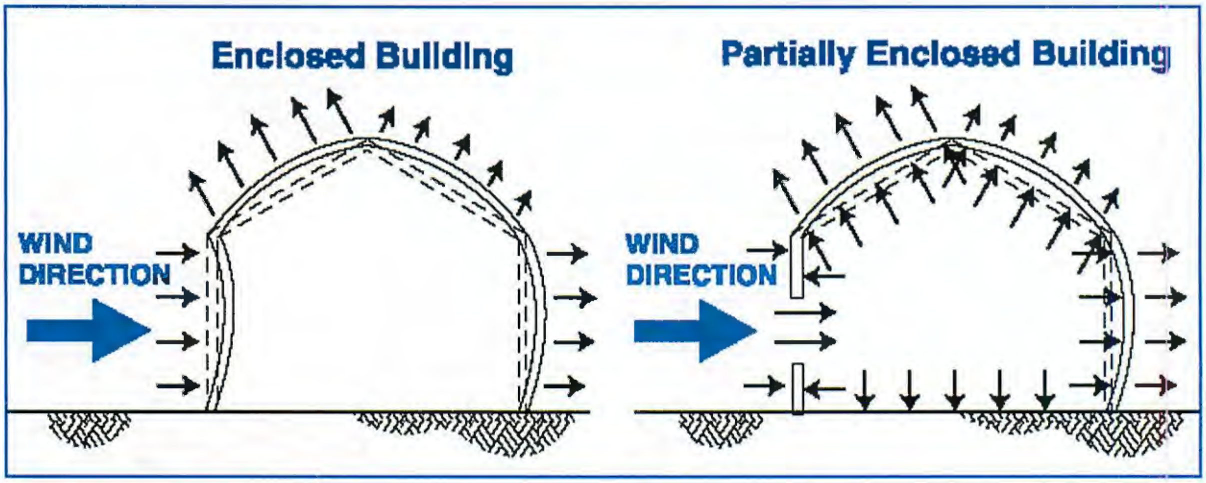


Figure 11-7 – Wind Pressure for Enclosed and Partially Enclosed Building. From FEMA CCM, 2000. – The need to create a wind and rain resistant envelope is depicted in this Figure. For an enclosed building, wind exerts pressure on the outside walls, creating stress on the walls and roof. For a partially enclosed building (e.g., a window breaks) external pressure from the wind plus internal pressure combine to increase stress on the roof and walls. The opening allows rain into the structure increasing damage from flooding. Uplift forces may double, increasing the chance of the roof lifting off (Institute for Business and Home Safety, 1998; www.mothernature.com). Once the roof lifts off, the walls are more likely to collapse, leading to total structural failure.

Wind design standards would apply to structures in the erosion, wave (V-VE), flood (A-AE-X) and inland zones (Figure 3-1). The first step in design is to determine the wind loads for specific portions of the proposed building. The formula and parameters to determine wind loads are in the applicable building codes (currently the UBC), the FEMA CCM and ASCE 7. The distribution of these pressures on different components of the building can then be determined (Figure 11-8).

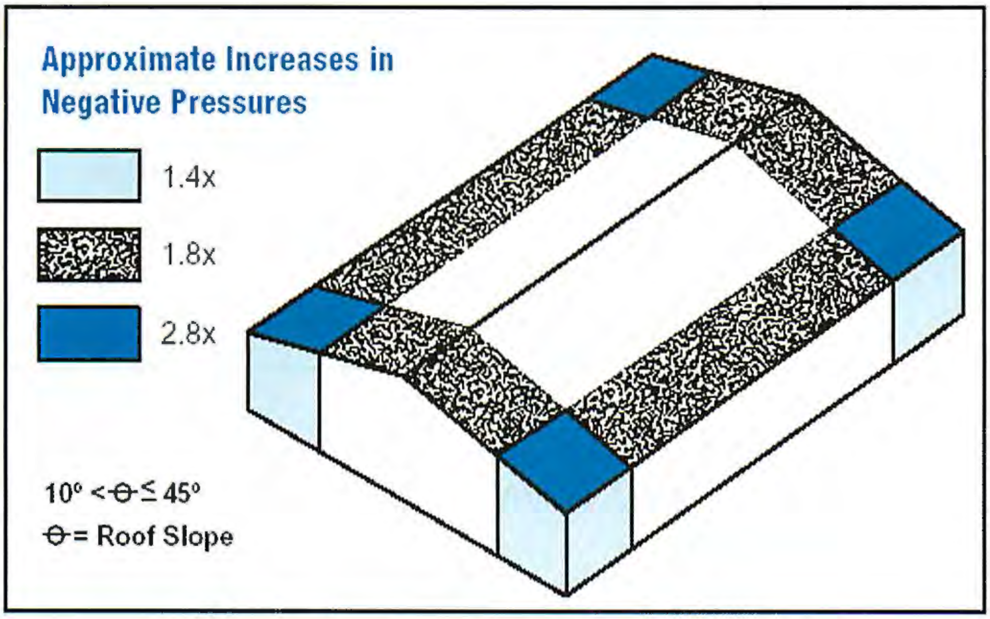


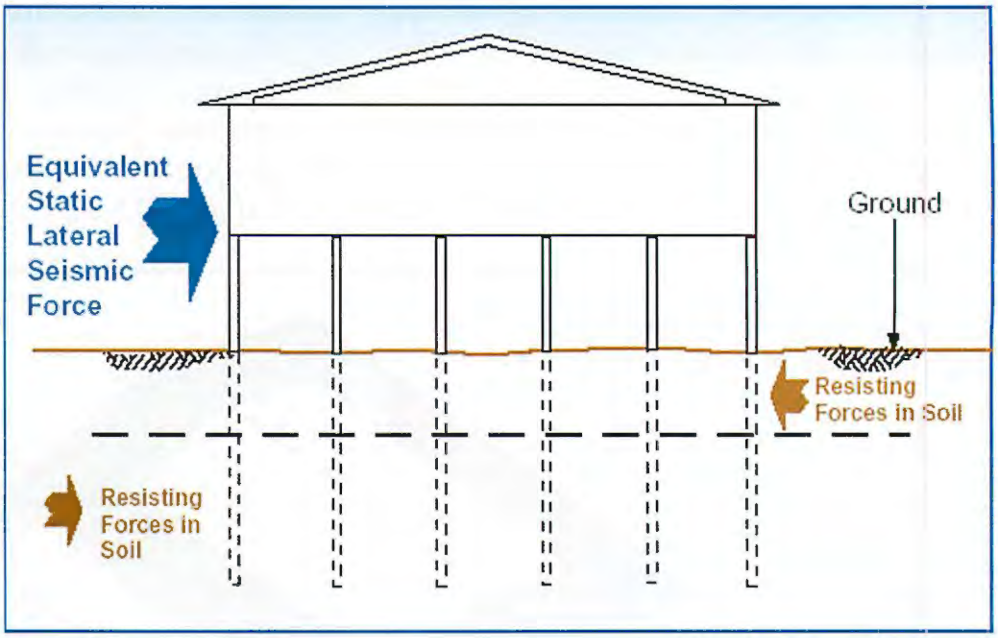
Figure 11-8 – Wind Pressure Distribution - Example of wind pressure along corners of building and edge of roof system. The design loads for connections for all wall sections must be designated. From FEMA CCM, 2000.

Once wind loads are determined, the building connections to resist these loads can be designed by themselves and in combination with other loads. For example, the possibility that wind and flood forces may act together is probable for coastal structures during a hurricane.

11.4.5 Seismic Loads

Houses constructed on columns or piers as required in the wave or V Zone may also be subject to seismic forces. This can create a conflict in design since ground motion from a seismic event displaces the foundation of the building more than the mass of the building above (Figure 11-9). The difference between the immediate displacement of the foundation and the building mass above creates stress on the supporting columns (FEMA CCM, 2000). This is a not a problem in Kauai, which is in seismic zone 1, but is a greater concern for Oahu (Seismic Zone 2A), Maui (Zone 2B) and especially Hawaii County (Seismic Zone 4) (Figure 3-7).

Figure 11-9 – V Zone Construction in Seismic Prone Areas – Structures built to V-zone standards and in earthquake areas have special concern because of the difference in movement between the foundation and building mass above. From FEMA CCM, 2000.



Seismic loads should be determined on buildings for the foundation and at each building level using the methods in the UBC, FEMA CCM and the IBC.

11.4.6 Combining Loads

It is possible that several hazards can occur simultaneously. Since wind and flooding loads are likely to occur during a hurricane, it would be important to combine these loads. Conversely, wind and seismic loads need not be assumed to act simultaneously, therefore the design does not need to combine these loads (FEMA CCM, 2000 and ASCE 7). Nevertheless, it is recommended that the most unfavorable affects of each hazard be considered in design.

For hazards occurring simultaneously, it would be important to combine loads prior to design following the applicable building codes, the FEMA CCM and ASCE 7. In addition, the individual building departments should be consulted regarding likely load combinations that should be considered.

11.4.7 Connection Design

With all loads calculated, it is possible to design connections to resist these loads. The connections must be of sufficient strength to prevent failure, given the design loads calculated for various portions of the building.

The FEMA CCM likens the load path connection to a chain running through the building and holding all components in place. This chain runs from the roof covering, to the roof support, to the top plate of the exterior wall, to the wall studs, to the window frame, to the exterior wall, to the floor frame, to the support beam or column (Figure 11-10). This continuous load path from the roof to the foundation is made of many links. Each link has to be designed to reduce failure or it can result in failure of the chain.

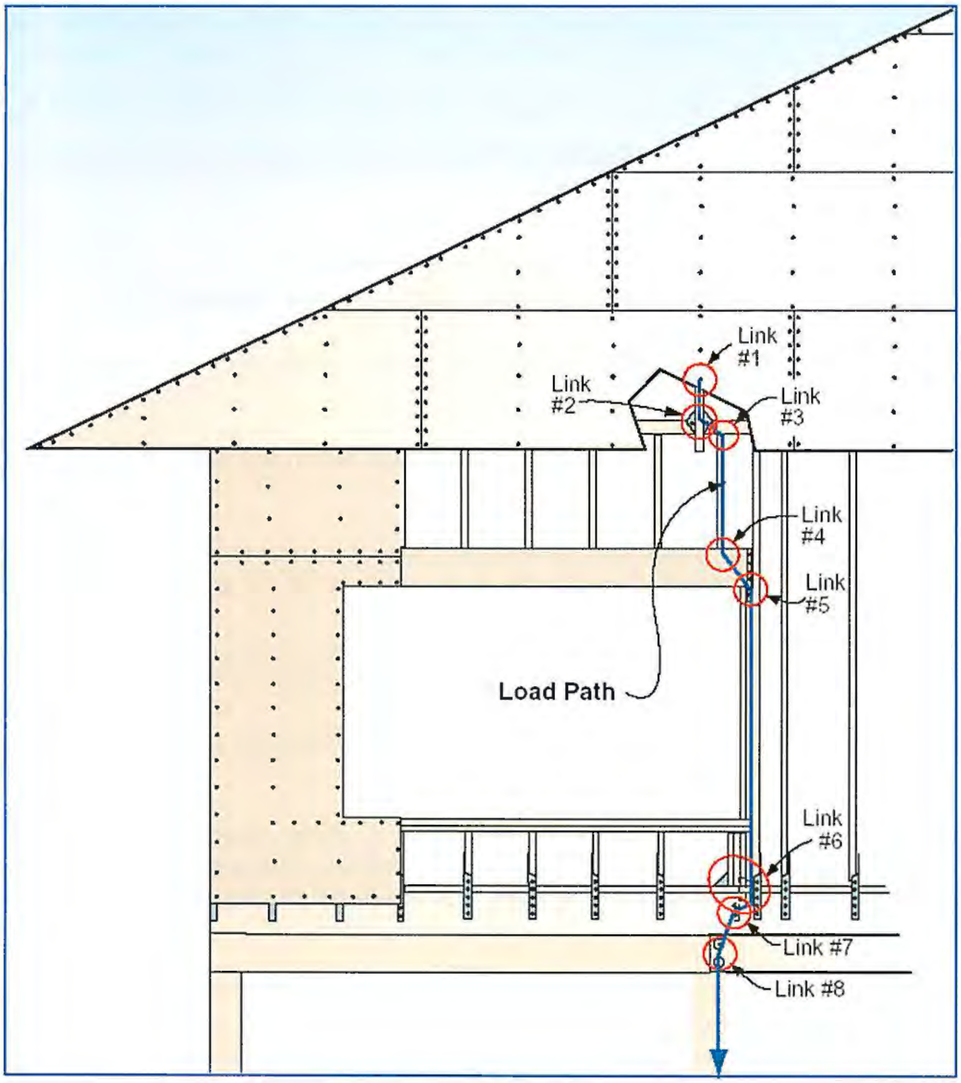


Figure 11-10 – Continuous Load Path Connection from Roof to Foundation. The connections for key components of a house must be sufficient to resist loads and be continuous from the roof to the supporting pile to the foundation. Information on the proper connectors for links 1 through 8 is in the FEMA CCM 2000.

The 1991 and 1997 UBC provide for the continuous load path approach in order to reduce the risks of structural failure (Appendix Chapter 23 of the UBC). A structure designed and approved before the effective date Chapter 23 was implemented by the individual county is at greater risks from hurricane damage. Care should be taken in comparing the design date of a structure with the effective date of Chapter 23 since a grace period is sometimes utilized to facilitate the transition to new building standards. The reader should check with the individual building departments to determine all relevant dates. As a general guide, the year that the 1991 UBC was adopted for the individual counties are: Honolulu (1994), Kauai (1992), Hawaii (1993) and Maui (1994) (Oahu Civil Defense Agency, 2003).

While all links in the continuous load path are important, the piles, anchoring and foundation are especially key to prevent uplift, overturning, and sliding. The reader is referred to the FEMA CCM (Chapter 12, 13 & 14) for guidance in this area. Conversely, it is the connection between the roof and walls which are especially important to prevent uplift of the roof and most of the damage from hurricane winds.[176]

11.5 Summary

The recommended guidance with regard to the construction of coastal homes at the infill lot stage is summarized in Figure 11-11.

Summary of Recommended Practices for Infill Lots – Home Construction

- If there is no current data, conduct an erosion study to determine an erosion rate and define the erosion zone.
- Avoid the erosion zone and locate the structure on higher ground within the existing lot using the methods discussed in Chapters 4 and 11.
- If the lot size is not sufficiently large, provide for a minimum buildable area utilizing a sliding scale based on original lot size. With the minimum buildable area, construct as far inland as possible.
- Implement by amendments to the shoreline setback rule or by policy, a prohibition on shoreline hardening for new structures that runs with the land and requires disclosure to future homeowners.
- Elevate structures above the Base Flood Elevation and provide freeboard (an extra margin of safety).
- Consider constructing structures in the Coastal A zone with V zone standards (FEMA CCM recommendation). If this is not economically feasible because of the large geographical extent of the A zone, consider building structures in the A zone that are likely to migrate into the V zone through erosion with V zone standards.
- Calculate loads for flood, wind and seismic events on building components utilizing the UBC, FEMA CCM, ASCE 7 and/or the IBC. Design connections to resist these loads utilizing these references. The building departments for the respective county should be consulted for applicable codes and recent amendments.
- Insure proper design and anchoring of pile supports to prevent uplift, overturning and sliding (FEMA CCM – Chapter 12).
- For all homes, create a wind and rain resistant envelope with impact resistant glass, or other impact resistant coverings (Figure 11-7).
- For all homes, create a continuous load path connection from the roof to the foundation to resist anticipated loads (Figure 11-10).

Figure 11-11 – Recommendations for Home Construction for Infill Lots

[176] Interview with Gary Chock, Martin & Chock, Inc.

Chapter 12 – Erosion/Hazard Noticed – Remedial Options Evaluated (Stage 8)

The prior Chapters in this guidebook cover planning at various stages of development to avoid or reduce the risks of natural hazards. Early planning is recommended because the hazard mitigation measures are easier to implement and are more effective when proper siting and design are in place before a hazard arises.

This Chapter covers situations in which there has been inadequate planning of coastal hazards during the siting and construction stages of development. The Chapter is applicable to houses that have been built along the coast and are subsequently threatened or damaged by erosion or other natural hazards.

12.1 Coastal Erosion

Once a home is constructed, and begins to experience erosion, the options to deal with the problem have traditionally centered on protective structures that harden the shoreline such as seawalls or revetments. Other alternatives include soft protective measures such as sand replenishment or dune restoration. Whether hard or soft shoreline erosion control techniques are utilized, this manual concurs with the FEMA CCM that these options are not substitutes for the need to plan and design coastal development to avoid erosion and/or hazard zones.

For a general discussion on the types of shoreline protection available, the reader is referred to the publication "Help Yourself - A Shore Protection Guide for Hawaii," published by the U.S. Army Corps of Engineers, Pacific Ocean Division in 1979. For a more detailed compilation of shoreline erosion control, the reader is referred to the "Shore Protection Manual," published in two volumes by the Corps of Engineers in 1984. At the time of this writing, the report "Erosion Management Alternatives for Hawaii" was being prepared by the University of Hawaii Sea Grant Extension Service and the State of Hawaii Department of Land and Natural Resources, Office of Conservation and Coastal Lands. These documents are cited in the reference section of this manual and they provide more information on shoreline erosion response than can be provided in this Chapter.

For professional advice regarding erosion, the reader should contact an experienced, qualified consultant. A partial list of companies or organizations providing consultant services with regard to shoreline erosion and ocean engineering is found in Appendix B.

12.1.1 Shoreline Hardening

Hardening of the shoreline usually refers to the building of a rock or stone barrier along the shoreline to prevent erosion of the backshore area. This method to control erosion has been the subject of controversy over the years because of the environmental impact on the shoreline of the State. As shown in Figure 1-2, shoreline hardening may cause loss of the beach. This method of shoreline control has been associated with the disappearance of about 25% of the recreational beaches on Oahu and miles of former beach areas on Maui (State of Hawaii, DLNR COEMAP, 1998). It could also be linked with the diminished utility of vertical and horizontal shoreline access routes for many of the State's shorelines (Figure 1-7).

Some shorelines around the State that have been hardened with a seawall or revetment do not have a lost or narrowed beach seaward (Figure 12-1). This may happen when a homeowner hardens the shoreline in response to a short term period of erosion (e.g., a storm event, seasonal erosion). A subsequent period of stability or accretion allows the beach to return in front of the wall.

Figure 12-1 – North Lanikai, Oahu - Example of a shoreline hardened with a seawall, and a beach in front. Many beaches with a history of alternating erosion or accretion, or short-term erosion may not be lost in front of the hardened shoreline.

While not all hardened shorelines have had their beaches disappear, many beach systems that have disappeared are backed by hardened shorelines (Figures 12-2, 1-5, and 1-6). For beaches that are undergoing long-term erosion, the natural response is for the beach to migrate inland. The hardened shoreline prevents that migration and also sand exchange with the dune system (Figure 1-1).

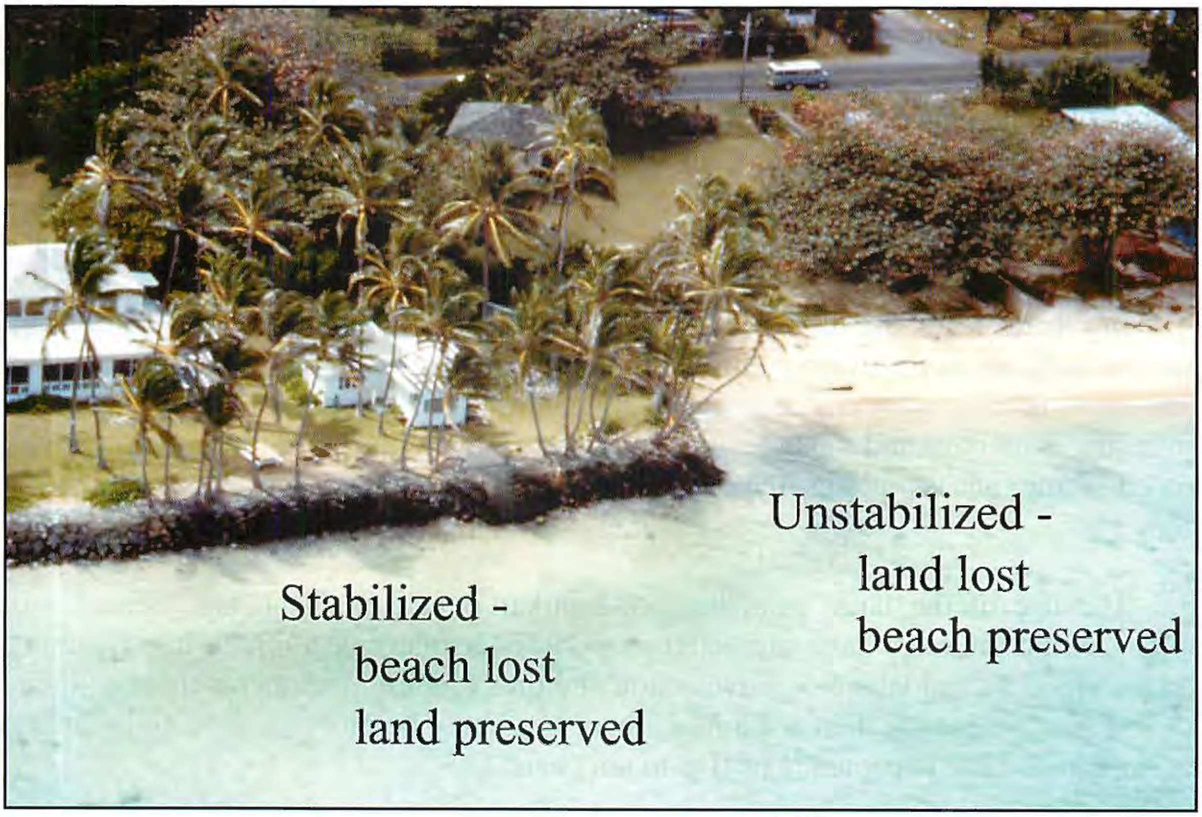


Figure 12-2 – North Shore, Oahu – For beach systems undergoing long-term retreat, stabilization with hardened structures will lead to the loss of the beach. For unstabilized shorelines, the beach is likely to remain, but migrate inland. From Fletcher, SOEST, UH.

Besides the environmental impact, the hardened shoreline should not be viewed as guarantee for the protection of coastal property. While the shoreline is temporarily stabilized, the seaward profile is steepened allowing larger waves to reach the shoreline. This can lead to catastrophic failure if the seawalls or revetments are not properly constructed or designed, e.g., a storm event is larger then the design event. This can also lead to an intense high energy zone where waves crash against the hardened barrier and impact nearby structures (Figure 1-10).

Testimony from condominium owners at Sugar Cove on Maui indicate such a situation caused homeowners considerable distress and reduced demand for the sale of coastal units. This problem was not solved until the historically natural beach was replenished with sand (Figure 12-5). Now, during high wave activity, sand on the replenished beach migrates offshore to create offshore bars which buffer the shoreline from wave attack (Figure 1-1). The Sugar Cove example demonstrates the importance of a healthy beach system in helping to mitigate the impacts from coastal erosion.

Although there are negatives associated with seawalls and revetments, this may be the only viable option, short of moving houses or allowing them to fall in the water, when structures are so close to the shoreline that no movement of the shoreline can be tolerated (Figure 1-11). Thus hardening of the shoreline is often the option of choice for homeowners, despite the discussed problems. This situation can be avoided with early planning of erosion and other hazards during the siting stages of development so that the natural shoreline movements can occur.

12.1.2 Sand Bags

In recent years, the use of large bags or geotextile tubes filled with sand has been used as a measure for erosion control (Figure 12-3). It was believed that the sand bags would provide temporary protection against erosion. These bags were larger and heavier than earlier sand bags and thus were more likely to stay in place. Furthermore, these bags allowed some access along the shoreline and were felt to be more aesthetically acceptable.

The use of the large sand bags at Lanikai Beach on Oahu has yielded mixed results. While the bags have protected property over many years, they have eventually been damaged by vandalism or wave action and thus require much maintenance. In areas with lower wave energy than at Lanikai, these bags may be more suitable and may reach their anticipated life expectancy of five to ten years.

Figure 12-3 – Large Sand Bags for Erosion Control, Oahu - Large bags or geotextile tubes are filled with sand, placed parallel to the shoreline and stitched together to form a barrier against erosion. Damaged and displaced sand bags are in the water.

While the use of large geotextile sand bags have been partially successful in protecting property, smaller sand bags such as used along the Kaanapali Coast of Maui lack the density and weight to offer protection from high wave action. These bags are more suitable for emergency or temporary protection in lower energy environments. The reader is referred to the report "Erosion Management Alternatives for Hawaii," for additional discussion on this option.

Figure 12-4 – Small Sand Bags for Erosion Control, Maui – Small sand bags are placed along this shoreline to protect trees and structures from erosion. The bags at Kaanapali have provided limited temporary protection as waves have eventually moved the bags along the shore.

12.1.3 Sand Replenishment

Sand replenishment is an option that has grown in popularity on the continental U.S. and in Hawaii as a means to protect coastal property. For some shoreline areas, sand replenishment can protect property, as well as preserve recreational values. In North Carolina, property damage from Hurricane Fran was significantly reduced for Wrightsville and Carolina Beaches which had replenishment projects versus Kure Beach, Topsail Beach, Surf City and North Topsail Beach which had no replenishment project (U.S. Army Corps of Engineers, 2000). Hurricane Fran was a category 3 storm that struck the North Carolina coast in 1996. The damage assessment was based in part on buildings destroyed by erosion, inundation by wave runup and flooding.

A factor that may make replenishment even more viable in Hawaii than on the mainland is that many of Hawaii's beaches have fringing reefs that reduce wave energy. Furthermore, the beach systems are sometimes broken into small littoral cells by cliffed coasts or promontories. These features provide a natural barrier to constrain the movement of sand.

A sand replenishment project at Sugar Cove, Spreckelsville, Maui County was able to substantially reduce winter wave energy, which threatened condominium owners (Figures 1-10 and 12-5). From testimony of residents, inland dune sand supplied to the area built the beach profile. During periods of high waves, the beach profile adjusted with the sand forming offshore shoals. These shoals caused storm waves to break further offshore and away from coastal property. The process of how the beach profile adjusts to changing wave climates is depicted in Figure 1-1.

Although sand replenishment has the potential to protect property and provide a recreational area, there are many challenges to a successful project that may prove insurmountable. First, sand replenishment is often a temporary means of protection that may require nourishment on a periodic basis. There would need to be a high degree of cooperation and commitment by a group of homeowners willing to maintain and finance the beach over the long term. Cooperation by the homeowners is not always possible, given the potential costs of replenishment.

Sand replenishment projects in Hawaii have failed for lack of adequate beach fill volume and lack of a physical container to constrain movement of the sand. The technical challenges are especially great for shorelines with high wave energy. A consultant should be contacted to discuss the feasibility of any potential project.

Figure 12-5 – Sand Replenishment, Maui – Inland dune sand placed on the beach has created a buffer zone that protected residents from high surf in the winter of 2001. During high wave activity, the sand created offshore bars that caused waves to break farther offshore. Photo by Barbara Guild, Maui.

A replenishment project also requires a suitable source of sand. The replacement sand should be similar in composition to the original beach and the grain size distribution should meet certain parameters. Standards for compatible sand are provided for in a proposed Department of Land and Natural Resources General Permit for small scale beach nourishment projects (Figure 9-5).

Another challenge for beach replenishment projects is the permitting process. The placement of sand below the high water mark triggers the need for an Army Corps of Engineers dredge and fill permit under Section 404 of the Clean Water Act. This in turn, triggers the need for a DOH water quality certification under Section 401 of the CWA and a federal consistency determination under the State Coastal Zone Management Program. In addition, a Conservation District Use Application permit from the DLNR is required as well as a Special Management Area and right of entry permit from the Counties. Approvals may also be required from the Historic Preservation Division of the DLNR for impact to burial sites.

There are efforts to streamline the permit process with a General Permit that covers all approvals for small scale replenishment projects. Nevertheless, for areas subject to erosion and in need of quick emergency response, the permit process alone can be a deterrent. The reader should check with the Department of Land and Natural Resources and the Army Corps of Engineers for all permits that are required and the status of any General Permit that is being developed. At the time of this writing, a small-scale beach nourishment general application was being developed by the Office of Conservation and Coastal Lands of the DLNR. The application is for projects less than 10,000 yd^3 of sand and would simultaneously cover approval of many agencies.

Sand replenishment may not be suitable for areas with unusually high wave energy; sparsely populated coastlines, or long stretches of beach with no natural barriers. If the area to be protected is in a high energy environment, structures such as groins may be needed to contain the sand. Sand replenishment will not eliminate all shoreline damage and may not be useful if the structures to be protected are very close to the shoreline (FEMA CCM, 2000). Finally, sand replenishment is generally not an alternative for the protection of a single lot since the entire beach system must be considered.[177]

Because of these challenges, sand replenishment should not be used as a reason to ignore hazard mitigation planning during the process of development. It is still easier to avoid an erosion or hazard problem with planning then to attempt to rebuild the beach in a manner that provides long term protection. Only for structures that are currently threatened (Stage 8), would the potential merits of sand replenishment come into play.

12.1.4 Dune Restoration

The importance of dunes in the protection of the coastal environment is depicted in Figure 9-1. Dunes should be preserved and, if they are damaged, restoration can help to mitigate the impacts from erosion and flooding. Successful dune restoration projects in Maui have taken place at Kamaole I, Kamaole II, and Memorial Beach Park (University of Hawaii Sea Grant Extension Service, 1997).

Appropriate activities to rebuild the dune include: (i) build dune walkovers to provide access without trampling dune vegetation, (ii) build dune fences to trap wind blown sand, (iii) renourish with beach quality sand (Figure 9-5) over soil, (iv) minimize or eliminate grading, (v) use natural vegetation, which is salt tolerant and easy to establish, over turfgrass, and (vi) if turfgrass is used in the backdune area, use a salt tolerant species such as seashore paspalum.

Dune restoration can be done in conjunction with a sand replenishment project. These projects will slow erosion and provide protection during temporary periods of high

[177] Interview with Scott Sullivan of Sea Engineering

energy. For coastal areas where the structures are very close to the shoreline, these measures may not offer complete or adequate protection. The reader should refer to a consultant or the local Sea Grant Office for more information on dune restoration.

Rebuilding or enhancing the dune should not be used to extend the certified shoreline seaward. Such an activity may put structures at an increased risk of exposure to coastal hazards such as erosion, flooding and wave inundation.

12.2 Hurricane Wind Damage

If a house is constructed prior to implementation of the 1991 UBC, it is not likely to have many of the protective measures that will help to mitigate wind and flood damage (See Section 11.4.7). Nevertheless, it is possible to retrofit the house to significantly reduce the risks from hurricane damage, in particular wind and rain.

For more information on this subject, the reader is referred to the following reports: (1) Federal Emergency Management Agency Coastal Construction Manual – Chapters 12 through 14; and (2) Institute for Business and Home Safety, "Is Your Home Protected from Hurricane Disaster? – A Homeowner's Guide to Hurricane Retrofit."

In addition, the website www.mothernature-hawaii.com has an extensive section on retrofit options for existing homes in Hawaii. According to the website, for an estimated cost of $8,000 to $10,000, or approximately 5% of the replacement cost, the average single family residence can be brought to a condition that will give reasonable assurance that it will survive an Iniki type hurricane with superficial damage. Mitigation priorities include: (1) keeping the roof on by improving anchoring and establishing a continuous load path; (2) protecting doors, windows and reinforcing the garage door to maintain the wind and rain resistant envelope; and (3) tying in the gable ends.

The above measures will help to create the wind-and-rain-resistant envelope that protects against flood damage and the buildup of internal pressure in a house (Figure 11-7). With proper anchoring and a continuous load path connection, any external or internal pressure can be resisted to protect the structure (Figure 11-10).

Chapter 13 - Conclusion

In Chapters 3 and 4 of this book, technically based standards for erosion and other coastal hazards are presented or discussed. Technical or scientific standards should serve as a design goal for implementation of hazard mitigation measures because compromise of a standard may expose future homeowners to unnecessary risks and potential property damage.

Once technical standards are set, regulatory flexibility and creativity can be used to implement strategies that take into account legal, political, economic, environmental and fairness factors to arrive at a realistic and balanced decision. Through the rest of this book, effort has been made to implement technical standards while balancing the numerous equity factors to derive at appropriate hazard mitigation measures. Much of that effort is summarized in Table 13-1 and is now discussed.

Key in the derivation of suitable mitigation measures was to divide the development process into stages as discussed in Chapter 2 and presented in column 1 of Table 13-1. Partitioning the development process allows the concerns of different parties and agencies to be addressed. At the same time, hazard issues pertinent to a particular development stage can be analyzed and appropriate measures crafted.

In Chapter 4, a technically based erosion standard is presented based on a life expectancy of 100 years for large or stone structures and 70 years for small wood frame residences. This technical standard has been placed in column 2 of Table 13-1. The agencies may wish to make their own analysis on the life expectancy of coastal structures. Such an analysis should consider building materials, maintenance, water damage, habitability, and other factors determined by the agency. Given the information currently available, 70 years is the best estimate for the life of small wood frame residences. In addition, the 70 year time frame appears to generate the proper setback given an erosion rate scenario of .5 ft/yr (see Section 4.1.8).

In column 3, it is shown, as a generalization, that the later in the development process erosion is addressed, the less likely that the technical standard can be implemented because of prior development decisions that become irreversible. For example, there is a very high probability that a scientific standard can be utilized in the land district classification stage, since prior decisions regarding the property, as well as investment backed expectations of the landowner will be minimal compared to all other development stages (See Figure 2-5). A high probability is also designated for the general & community planning and zoning stages because these processes are early in the development process and linked. Since it is later in the process, a high to average probability is assigned to the subdivision and infrastructure stages, which are likely to be concurrent. Note, however, that after land has been subdivided and sold, the difficulty in implementing a technical standard is greatly magnified due to the creation of small lots and the investment backed expectation of lot purchasers. Therefore, an average probability is assigned at the home construction stage. The most difficult stage to implement a technically based setback standard would be after a nonconforming house has been damaged or destroyed (See Section 11.3.1).

There are always exceptions to the above generalization. For example, given a large erosion/hazard zone and a small coastal lot, it may be difficult, without other implementation strategies, to utilize a technically based setback standard at Stage 1. Conversely, there are many large coastal lots around the State that have already been subdivided and can easily accommodate a scientific setback standard at the home construction stage.

Column 4 in Table 13-1 summarizes proposed measures in the guidebook that can be employed in the case where the technical standard is overly burdensome. For land district classifications, general & community planning or zoning (Stages 1-3), common options listed are: (i) variances to relax the standard; (ii) open space incentives that allow increased buildable area for an increased setback and (iii) other compensation in the form of purchase of the fee, purchase of development rights, land swaps, or transferable development rights. Great regulatory flexibility is provided in both how the mitigating options are crafted and at what threshold the options are triggered.

For a subdivision and infrastructure improvements (Stages 4-5), a key to the implementation of technical standards is to provide for regulatory flexibility and creative design through the use of Planned Unit Developments, Planned Developments, Project Districts and Cluster Developments (Chapter 8). Open space incentives can also be created through a system of variances or as specific provisions in the subdivision regulations. Further flexibility is provided in setting the percent threshold that triggers ameliorating options.

Even for home construction (Stage 7), it is recommended that technically based setback standards be utilized. Any major impact for such a late development stage can be greatly reduced by the use of minimum buildable areas tied to the original lot size (Chapter 11). Agencies have great flexibility in setting suitable percentages for the various sizes of lots.

The issue of damaged or destroyed nonconforming structures is discussed in Chapter 11 because of its linkage with home construction and the passage of shoreline setback rules. In reality, this topic can also be placed in Chapter 12 - Erosion/Hazard Noticed-Remedial Options Evaluated. For damaged or destroyed nonconforming structures, it is recommended that the major effort to implement technically based setbacks be through a regulatory or open space incentive program. In developing this strategy, consideration is given to the greater financial and emotional attachment existing homeowners have for their property (Stage 8) compared to a recent lot purchaser about to construct (Stage 7).

The discussion in this Chapter so far relates to the implementation of a scientifically based erosion setback standard. It is a major tenant of this guidebook that if the standard is overly burdensome, the standard not be changed but the method of how it is implemented in order to reduce impact to landowners. For example, instead of relaxing the 70 year technical standard because of the concern for small lots, it would be preferable to keep the standard so that it can be applied to large lots. When small lots are encountered, any impact can be addressed with a minimum buildable lot provision tied to original lot size. As noted above, great flexibility is provided in how these provisions are created.

The strategies and measures in this manual can be utilized for the implementation of any hazard mitigation siting standard, whether it be for coastal erosion, bluff erosion, flooding, hurricanes, tsunamis, lava, subsidence, or earthquakes. The key for these hazards is to define the extent of the hazard zone that can not be adequately mitigated through proper construction techniques.

Finally, the measures in this manual are designed given Hawaii's current regulatory regime. The measures can be used to streamline the permit process if they become established and serve as a standard for hazard mitigation analysis for many different levels of regulatory approval.

Table 13-1 – Development Stages, Technical Standards, Probability of Implementation and Ameliorating Options

Development Stage	Recommended Technically Based Erosion Standard *(Chapter 4)*	Probability that Project can Implement Technically Based Erosion Standard *(Chapter 2, Figure 2-5)*	If Standard too Burdensome for Project (e.g. 50-75% threshold met – Section 5.5), Recommended Remedy	Comments
1. District Classification *(Chapter 5)*	100 for large or stone structures – 70 year for small wood frame	Very High	Open space incentives Variances Compensation	Flexibility provided by measures in column 4 and setting % threshold trigger
2. General & Community Planning *(Chapters 6 & 7)*	100 for large or stone structures – 70 year for small wood frame	High	Open space incentives Variances Compensation	Flexibility provided by measures in column 4 and setting % threshold trigger
3. Zoning *(Chapters 6 & 7)*	100 for large or stone structures – 70 year for small wood frame	High	Open space incentives Variances Compensation	Flexibility provided by measures in column 4 and setting % threshold trigger
4. Subdivision *(Chapter 8)*	100 for large or stone structures – 70 year for small wood frame	High-Ave	Innovative, Creative Design Open space incentives Variances	Flexibility provided in innovative design, regulatory incentives, and variances
5. Infrastructure Improvement *(Chapters 8 & 9)*	100 for large or stone structures – 70 year for small wood frame	High-Ave	Innovative, Creative Design Open space incentives Variances	Flexibility provided in innovative design, regulatory incentives, and variances
6. Lot Transfer *(Chapter 10)*	N.A.	N.A.	N.A.	Proper disclosure encourages use of technical standards throughout the development chain.
7. Home Construction *(Chapter 11)*	70 year standard	Ave	Minimum Buildable Areas Tied to Lot Size.	Flexibility provided in setting minimum buildable area. (*See Section 11.1*
8. Erosion -Hazard Noticed (damaged nonconforming structure) *(Chapters 11 & 12)*	70 year standard	Ave-Low	Existing Use Status, Regulatory Incentives Open Space Incentives	Flexibility in incentives for open space. Other options provided in *Table 11-1*

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Appendix A - Existing Reports

In this Appendix is a summary of key coastal zone management reports taken directly from the State of Hawaii Coastal Erosion Management Plan (COEMAP), Technical Supplement, Part A, State of Hawaii, Department of Land and Natural Resources, Coastal Lands Program; School of Ocean and Earth Science and Technology, University of Hawaii, Technical Report 98-04, Updated 2001). The summary has been adapted and updated to include significant works completed by the University of Hawaii in 2001 & 2002. These recent reports provide an additional source of information that can be used for the planning of coastal hazards.

INTRODUCTION

Beaches are one of Hawaii's most important resources. They are precious natural features that provide recreational opportunities and scenic beauty. Hawaii's beaches are critical for tourism, the primary industry of the State, and are culturally important to the residents of Hawaii. Furthermore, beaches, dunes, and offshore sandbars help minimize risks from coastal hazards by dissipating wave energy which may otherwise damage inland property. Beaches are also important as habitats for seabirds, turtles, seals and other animals and plants.

One of themes heard most often at coastal zone management public meetings is a concern about the "loss of beaches." Clearly, "loss of beaches" means different things to different individuals and communities. Some are talking about the literal loss of beaches by means of erosion that in many cases has already reduced recreational areas and threatened property. In this context, erosion, and legal and illegal erosion control structures, such as seawalls, are a concern. Others are referring to continuing loss of coastal open space that they associate with particular beaches or the construction of homes and hotels that block views along the shorelines. Loss of beaches also connotes reduced access to popular beaches because of new construction, leasehold conversion, reduced parking or other impediments. It also means increased competition among residents and visitors for limited beach space and competition among different types of recreational activities.

Some of these problems are addressed by the shoreline setback and special management area provisions of the Coastal Zone Management (CZM) Program. However, to increase our understanding of the problems and issues and to develop mechanisms to improve beach management, a number of beach management studies have been conducted.

Hawaii CZM Program Beach Management Projects

<u>Beach Changes on Oahu as Revealed By Aerial Photographs</u>, prepared by Dennis Hwang for the Department of Planning and Economic Development by the Urban and Regional Planning Program and the Hawaii Institute of Geophysics, University of Hawaii, 1981.

This report analyzes aerial photographs of the beaches of Oahu taken over a period of up to 50 years. To determine whether accretion or erosion had taken place, changes in the beach vegetation line at designated transects are recorded. Transects are conducted at approximately 1,000-foot intervals. The vegetation lines of sequential photographs are then compared to determine the net movement of sand.

To characterize the sandy shore of Oahu, the report develops 5 classifications: hazard area, chronic erosion area, unstable beach area, stable beach area, and accreting beach areas. It notes that areas classified as hazard, chronic erosion, and unstable should be areas of greatest concern to coastal managers. Also, the report indicates that many buildings have been placed in areas extremely vulnerable to large wave inundation.

Recommendations

Hazard areas

1. Establish a minimum 80-foot setback from the vegetation line for all new subdivisions.

2. Prohibit new houses within the new 80-foot zone.

3. Carefully analyze reconstruction after destruction of previous structures and buildings.

4. Discourage the reduction of dunes or berms for vista creation because of their role in protecting backshore areas from large waves.

Chronic erosion areas

1. To determine rate of retreat, conduct periodic field or aerial surveys.

2. Prohibit new subdivisions that require building in these erosion areas.

3. Determine the extent of setback using local erosion rates and the life expectancy of proposed structure.

Unstable beach areas

1. Avoid development in accretion areas to avoid destruction during the erosional phase of the cycle characteristic of these areas.

2. Obtain appropriate setback for unstable beach areas by adding the historic range of the vegetation line position and a buffer of 40 ft.

Accreting beach areas

1. Generally, in accreting beach areas, there are no major problems. However, ownership of accreted land may be a concern.

Stable beach areas

1. No major problems exist in these areas, except for tsunami and storm damage possibilities.

<u>Hawaii Erosion Management Study</u>, prepared by Edward K. Noda and Associates, Inc., and DHM Inc., for Hawaii Coastal Zone Management Program, 1989.

The study provides a comprehensive overview of erosion and erosion management in Hawaii as an initial step towards the development of a uniform method or regulatory process for the implementation of non-structural and structural measures.

Numerous factors affecting shoreline erosion control are discussed, including coastal processes, probable long-term erosion trends, methods for estimating long-term shoreline change, shoreline protection/stabilization, and erosion management and regulation. Specific case study sites apply these factors. In addition, reviews of states with more advanced erosion management systems (i.e. Florida and North Carolina) are included.

Alternative shoreline stabilization mechanisms, fitting of shoreline stabilization alternatives to various geological, land use and development scenarios, and benefit/cost analyses are discussed. A proposed system to improve erosion management in Hawaii is developed.

Recommendations

1. Develop a statewide approach to funding, planning, and designing appropriate shoreline erosion counter-measures in Hawaii (CZM Office - preliminary role)

2. Coordinate the counties in the development of an on-going system for beach erosion monitoring. This includes routine data collection, aerial photography, computer mapping, and erosion rate projections. (CZM Office - lead role)

3. Monitor and enforce erosion management regulations. (Counties lead role)

4. Classify littoral cells as stable or unstable through a program of data collection and analysis and then determine appropriate shoreline setbacks, considering land use and erosion rates.

5. First, develop long-term erosion plans for critical, unstable, and erosion-prone areas involving combinations of structural and non-structural remedies. Second, develop site-specific management plans for these areas.

6. Littoral cell erosion management plans should include policies and programs for alternative management and financing of physical structures that benefit private property owners.

7. Streamline the permit process and clarify erosion policy objectives in federal, state, and local permits.

8. Develop in-house expertise and knowledge of coastal processes and engineering principles in government agencies with management and regulatory responsibilities.

Oahu Shoreline Study, Part 1. Data on Beach Changes, prepared by Sea Engineering, Inc., for the City and County of Honolulu, 1988.

The study produced two products. The first is a collection of 1988 aerial shoreline photographs and computer-generated images from these photographs which depict recent shoreline changes. The second product is an update of the study, Beach Changes on Oahu as Revealed by Aerial Photographs (1981). The 1988 changes are measured and summarized in tables that include the results of the 1981 report.

Oahu Shoreline Study, Part 2. Management Strategies, prepared by Sea Engineering, Inc., for the City and County of Honolulu, 1989.

Shoreline setback and management recommendations are provided for each beach sector studied on Oahu. The management strategies are developed by integrating the beach change data with existing land use data, the extent and conditions of existing shore protection, existing beach conditions, and qualitative and quantitative knowledge of continuing beach processes.

Beach-specific setback recommendations

1. Extend shoreline setbacks to comply with recommendations of this report (primary recommendation).

2. Review zoning along Oahu's shoreline within the context of existing and recommended setback provisions.

3. Investigate the establishment of "beach improvement districts."

4. Review the provisions of the Shoreline Setback Rules.

5. Focus shoreline setback provisions prohibiting development in the shoreline sectors on habitable, protective, and other structures that might impede natural shoreline processes.

6. Monitor the shoreline more closely for illegal shoreline construction. Amend the Shoreline Setback Rules to establish fines for setback violations. Institute a program for monitoring setback violations by conducting shoreline aerial photography every two to four years.

7. Implement the shoreline setback provisions with close coordination between the DLU and the State Department of Land and Natural Resource (DLNR).

Beach-specific management policies

1. Set examples of shoreline preservation with City and County beach parks.

2. Establish public rights-of-way to all beaches to ensure public access.

3. Update the data in this report every eight to ten years.

<u>Erosion Management Program Recommendations for Hawaii</u>, prepared by Oceanit Laboratories, Inc., for Hawaii Coastal Zone Management Program, 1990.

The report proposes the development of a comprehensive database on erosion, based on the analysis of aerial photography using computerized methods for calculating historic rates of beach recession. Guidelines for evaluating and recommending solutions to erosion problems are also proposed. A list of information requirements and a set of questions that should to be raised in dealing with site-specific erosion problems is included. Other recommendations are to develop a comprehensive erosion plan and create an Office of Beaches. In addition, a proposed mission statement, guidelines, goals, and objectives for the erosion management program are discussed.

Recommendations

Informational Recommendations

1. Establish a database for the coastal zone of Hawaii, including oceanographic, topographic, land and water uses.

2. Use aerial surveys and a computer-aided digitizing method for monitoring the total coastline of Hawaii, supplemented with shoreline surveys at selected high-risk locations.

3. Coordinate federal, state, and county erosion management funding to develop a comprehensive database for coastal areas.

Planning Recommendations

1. Define the certified shoreline and tie it into survey monuments. Revise the line continuously to account for erosion.

2. Simplify the permit process and inform coastal land users of permit requirements in their areas.

3. Create a master plan for state erosion management addressing the nature and cause of erosion problems, problem assessment, and immediate, medium, and long-term mitigative activities.

4. Develop a comprehensive State coastal erosion plan as part of a shoreline plan.

5. Consolidate jurisdiction and regulatory powers of the shoreline area into one agency. Establish a separate division within an existing agency responsible for handling these matters. The division would be responsible for:

    a) periodic updates of coastal database;

    b) regulating shoreline uses in accordance with the coastal erosion plan;

    c) conducting enforcement matters relative to illegal uses or structures; and

    d) implementing beach renourishment or shore protection measures when necessary.

Resource Management Recommendations

1. Clarify and strengthen enforcement power over the actions and results of coastal area construction.

2. Delineate areas susceptible to erosion damage from storm waves, surge and inundation.

3. Create maps of the hazard areas and inform public of restrictions on protecting properties in these areas.

Kauai Shoreline Erosion Management Study, prepared by DHM Inc., Edward K. Noda & Associates, Inc., and Moon, O'Connor, Tam & Yuen for Hawaii Coastal Zone Management Program, 1990.

The study develops appropriate management recommendations for Kauai shoreline areas, analyzes the impacts of these recommendations, and develops specific shoreline erosion management plans for selected areas of Kauai. Aerial photographs were used to evaluate historic shoreline movements. Beach vegetation lines, waterlines, and selected features in Hanalei Bay and the Haena-Wainiha area were digitized into a computer- aided drafting (CAD) system. The long-term shoreline change data are used to develop shoreline management recommendations.

Legal, social, and economic impacts of both the recommended regulatory changes to shoreline setbacks and the adoption of Shore Districts as an erosion management tool are discussed. Shore Districts allow the Kauai County Planning Department discretion in establishing shoreline setbacks in these areas. Possible implementation mechanisms for the recommendations are included.

Recommendations

1. Give non-structural remedies preference over structural remedies for shoreline management on Kauai.

2. Remove illegal shoreline structures.

3. Enforce more strictly all regulations affecting coastal development and beach preservation.

4. Establish setbacks of no less than 60 feet for Haena area and 75 feet for Hanalei Bay.

5. Develop and update a shoreline structure inventory.

6. Create overlay Shoreline Special Districts as specified in the Kauai Comprehensive Zoning Ordinance for the Hanalei, Haena-Wainiha, and Poipu areas.

7. Develop a Shoreline Special Treatment Zone Plan for adoption by the Kauai Planning Commission.

8. Establish an 80-foot shoreline setback for the Poipu Beach Park area.

Aerial Photograph Analysis of Coastal Erosion on the Islands of Kauai, Molokai Lanai, Maui and Hawaii, prepared by Makai Ocean Engineering, Inc., and Sea Engineering, Inc., for the State of Hawaii Office of State Planning Coastal Zone Management Program, 1991.

Approximately 66.2 miles of sandy shoreline are included in the study. Aerial photographs from different years are analyzed for each area selected to determine historical changes in shoreline positioning. To determine erosion and accretion rates, photographs were digitized, corrected, and compared. This report is in atlas form with a description of the coastal characteristics, beach history, backshore development, shoreline processes, and beach usage; graphs depicting erosion and accretion rates between photographic dates; and a diagram of each shoreline area. The diagram of each shoreline area includes shoreline protection structures, 1988 water and vegetation lines, roads and buildings, and the transect lines used for the analysis.

Recommendations

1. For future monitoring efforts, focus on areas that are not already committed to shoreline protection structures.

2. Develop and implement a program to select beaches needing more frequent and/or detailed monitoring.

3. For the monitoring program, select beaches that are eroding, slated for future development, or already have shoreline protection that might affect the beach.

4. For every monitored beach, take a complete set of overlapping vertical and low-level oblique color aerial photographs every five years. The low-level oblique photographs will help interpret the vertical photographs and document further beach dynamics.

5. Add new data on shoreline change to the existing digital database.

1991 Oahu Shoreline Management Plan, prepared by Sea Engineering, Inc., and Barbara Moon for The City and County of Honolulu Department of Land Utilization, 1991.

The report focuses on 31 miles of sandy beaches on Oahu that 1) are being developed primarily for residential *use,* 2) are high-quality recreational beaches that should be preserved for public use, and 3) were recommended in Part 2 of the Oahu Shoreline Study for increased shoreline setbacks. The study:

1. identifies natural beach sectors that are high-qualify public recreational resources;

2. develops alternative strategies to preserve beaches;

3. examines potential impacts of alternative strategies on existing residences and other private land abutting the shoreline; and

4. recommends government regulations and other actions to implement a plan encompassing the most promising strategies.

Digitized maps showing all major features were created for the 13 miles of residential shoreline properties were created. This study predicts future shoreline positions and provides information on the statistical variability of the prediction.

Recommendations

Short-term, cost-effective, low impact strategies

1. Eliminate the 20-foot shoreline setback permitted under certain condition.

2. Require a minimum area of 3,000 square feet buildable lot area for residential beachfront properties.

3. Prohibit shoreline setback credit for property owners who acquire, through land court and/or consolidation and resubdivision, accreted shorefront land.

4. Require a minimum setback of 60 feet for new developments on vacant land, or redevelopments resulting in a higher unit count.

5. Create a mechanism to grandfather illegal shoreline protection structures that meet criteria established by technical engineering and design standards.

6. Prohibit the use of vertical seawall structures in areas where this form of protection is not wide-spread and where future seawall requests are likely. Require buried

revetments or similar form of private property protection, if necessary, without complex permitting requirements.

7. Strengthen criteria for granting shoreline setback variances by stricter standards for proving "hardship"

8. Apply established administrative enforcement procedures to violations within the shoreline setback area.

Long Term Strategies

1. Amend the City and County of Honolulu Land Use Ordinance (Article 7) or the Special Management Ordinance to create a Beach Preservation District to manage beach sectors subject to chronic long-term erosion or episodic and severe erosion.

2. Establish objectives for each District sector and develop specific regulatory requirements for problems specific to the sector.

3. Adapt the existing Improvement District approach to vulnerable beach sectors necessitating public/private cost-sharing.

4. Establish and fund a recruitment and training program for professional monitoring and enforcement staff.

The Hawaii Ocean Resources Management Plan, prepared by Hawaii Ocean and Marine Resources Council, 1991.

The Office of State Planning, as a member of the Hawaii Ocean and Marine Resources Council, was involved in the development of the Hawaii Ocean Resources Management Plan. This Plan addresses broad ocean management issues as well as specific ocean management sectors, including beaches and coastal erosion. The stated objective for beaches and coastal erosion is to develop an integrated State erosion management system that ensures: 1) the preservation of sandy beaches and public access to and along the shoreline; and 2) the protection of private and public property from flood hazards and wave damage. Policies and implementing actions are also included. The policies are listed below:

1. Establish and maintain a comprehensive coastal shoreline survey, database, and other research.

2. Coordinate County, State and Federal erosion and beach-management efforts.

3. Exercise greater enforcement of laws and regulations.

4. Ensure the continued natural production of sand and assess the potential for using beach replenishment.

5. Promote an erosion-control structure limitation strategy.

6. Develop an active public participation and education program to preserve and protect beaches.

7. Maintain and develop access to beaches and along the shoreline.

8. Assure adequate funding resources and personnel.

9. Plan for climate change, sea-level rise, and emerging issues.

Beach Management Plan with Beach Management Districts, prepared by Dennis Hwang and Charles Fletcher for Hawaii's Coastal Zone Management Program, 1992.

The purposes of the study were to develop a comprehensive and coordinated management plan to preserve pristine beaches while allowing for "intelligent and safe" development along with shore and to address the erosion problems of currently-developed sections of the coast. The report found that, since 1928, approximately 8 to 9 miles (or close to 15%) of the sandy shorelines studied on Oahu have disappeared or been negatively impacted by shoreline stabilization structures. The loss of beaches is also occurring on Hawaii's other islands. Beach loss has accelerated due to a combination of factors such as sea-level rise and hardening of the shoreline. The report notes that beach loss is likely to accelerate unless there is a fundamental change in beach resource management.

Beach Management Districts (BMDs) are recommended as an alternative to hard control structures. The three general forms of BMDs finance the study and implementation of possible erosion control alternatives. Other states, such as Florida and Maryland, have successfully implemented BMDs.

Recommendations:

1. Establish an agency responsible for the administration and management of beaches.

2. Establish improvement and overlay districts to help in the management of Hawaii's beaches.

3. Promote erosion control devices other than traditional hard control structures through Beach Management Districts.

4. Distribute the cost of preventive erosion measures between the State, counties, and coastal landowners.

5. Develop an education program to convey the problems of beach loss, erosion, and sea-level rise to the public.

6. Enable the modification of shoreline setback regulations through new legislation.

7. Concentrate further research on the monitoring of beaches with aerial photographs and beach profile surveys to facilitate proper beach management decisions.

8. Investigate the prospect of using offshore sand deposits as a cheap source for renourishment projects.

Beach Nourishment Viability Study, conducted by Sea Engineering, Inc. and Lacayo Planning for the Hawaii Coastal Zone Management Program, 1993.

This study explores the viability of beach nourishment from offshore sand sources. Hawaii's, and other states,' procedures, permits, and environmental assessment requirements associated with offshore sand mining and beach nourishment are reviewed. Options are presented to adjust Hawaii's management framework to facilitate rather than discourage beach nourishment by casting regulatory requirements in a more supporting role. In addition, the report reviews previous investigations of Oahu's offshore sand resources, synthesizes and presents the useful data, describes an unsuccessful effort to profile an offshore sand deposit, and outlines a future work plan for sub-bottom profiling

Recommendations:

1. Establish an office of beaches within the Division of Boating and Ocean Recreation, DLNR.

2. Establish a Department of Environmental Protection to facilitate more effective administration of water quality regulations relative to beach nourishment projects.

3. Repeal the section of Chapter 205A, HRS that enables the counties to prepare beach management plans and extend their jurisdiction makai to the high water line, providing instead that the new state office of beaches be the lead agency for beach management.

4. Amend Chapter 183, HRS, and Title 13, Chapter 2, HAR, to create a new subzone in the conservation district for all submerged lands and beaches. Include a distinct set of objectives for the conservation of ocean and beach resources, and regulations to facilitate non-structural approaches to shoreline protection.

5. Implement the "master CDUA" concept for beach nourishment activities. Also, delegate the BLNR's decision-making authority to the DLNR's Office of Conservation and Environmental Affairs.

6. Continue the research in shoreline erosion and beach management issues through the CZM Program, but transfer the lead role for research to the proposed office of beaches.

7. Request the State Legislature to establish a dedicated fund for shoreline research and beach management activities, into which revenues from fines, licenses, damage awards, and permit application fees for shoreline-related activities shall be deposited.

8. Charge the proposed office on beaches with responsibility for preparing beach management plans.

9. Charge counties with responsibility for establishing and administering assessment districts for private shoreline properties that benefit from shore protection projects.

Recent University of Hawaii – School of Ocean & Earth Science Technology Projects

<u>Hawaii Beach Monitoring Program: Beach Profile Data</u>, by Anne E. Gibbs, Bruce M. Richmond, Charles H. Fletcher, and Kindra Hilman for the U.S. Department of the Interior, U.S. Geological Survey, School of Ocean & Earth Science Technology, 2001.

Between August 1994 and July 1999, biannual beach profiles were collected at 42 Oahu and 36 Maui locations. Surveys were conducted at approximately summer-winter intervals. The profiles were conducted to establish baseline beach conditions, monitor seasonal beach fluctuations, and understand the dynamics of beach change in Hawaii. This would help to document the coastal history in Hawaii, determine the causal factors of erosion, provide high-quality data for other "end-users" and increase the general understanding of the impact of coastal development.

<u>Maui Erosion Study</u>, by Charles H. Fletcher III for the Maui County Planning Department and School of Ocean & Earth Science Technology, 2002.

The Maui Erosion Study provides long-term shoreline erosion data for the North Shore, West Coast and Kihei Coast of Maui. An average annual erosion rate is determined using aerial photographs and National Oceanic & Atmospheric Administration T sheets. The data covers the period from 1900 to the late 1997. The erosion rate is from linear regression and end point analysis. Shore normal transects are established and the movements of the beach toe are monitored. Once an erosion rate is calculated, it is projected 30 years into the future.

<u>Atlas of Natural Hazards in the Hawaiian Coastal Zone</u>, by Charles H. Fletcher III, Eric E. Grossman, Bruce M. Richmond, and Ann E Gibbs for the U.S. Department of the Interior, U.S. Geological Survey, School of Ocean & Earth Science Technology, 2002.

The Atlas communicates to citizens and regulatory authorities the history and relative intensity of coastal hazards in Hawaii. This information is key to the proper management of coastal resources. The information can improve the ability of Hawaiian citizens and visitors to safely enjoy the coast and provides a strong data base for planners and managers to guide the future of coastal resources.

The work is largely based on previous investigations by scientific and engineering researchers and county, state and federal offices and agencies. The Atlas assimilates efforts in documenting Hawaiian Coastal Hazards and combines existing knowledge into a single comprehensive coastal hazard data set.

Both small scale and large scale maps are provided that summarize the risks from tsunamis, stream flooding, high waves, storms, erosion, sea level rise, and volcanic-seismic activity for various sections of the Hawaiian coastline.

Appendix B - Coastal Engineering Consultants

To assist in planning to minimize risk from coastal hazards, it is recommended that an experienced consultant be retained for projects that are near the coast. This manual provides information on organizations specializing in coastal engineering or shoreline protection work. This is not a complete listing of all companies or organizations working in this area. This manual is not intended to serve as an endorsement of the entities listed herein. Determination of the companies qualifications are the sole responsibility of the reader.

Makai Ocean Engineering Inc.
P.O. Box 1206
Kailua, Hawaii 96734
808-259-8871

Noda Edward K & Associates Inc.
615 Piikoi Street, Suite 300
Honolulu, Hawaii 96814
808-591-8553

Oceanit Laboratories Inc.
1000 Bishop Street, Suite 2970
Honolulu, Hawaii 96813
808-531-3017

Olsen Associates, Inc.
4438 Herschel Street
Jacksonville, Florida 32210
904-387-6114

School of Ocean and Earth Science Technology
University of Hawaii
2525 Correa Road
Honolulu, Hawaii 96822
808-956-7640

Sea Engineering, Inc.
Makai Research Pier
Waimanalo, Hawaii 96795
808-259-7966

Appendix C - Aerial Photographs

Aerial photographs can be used to determine historic shoreline changes and thus, can be helpful in planning for erosion that is likely to occur in the future. Beginning in the late 1940's, much of the Hawaiian coastline was photographed on a regular basis, with some areas having aerial photographic coverage every five to ten years. The exact coverage for each area will vary with different sections of the coastline and for different islands. Photographs that date back to the late 1920's may be available at the United States Geological Survey.

Air Survey Hawaii
22 Lagoon Drive
Honolulu, Hawaii 96819
808-833-4881

National Oceanic and Atmospheric Administration
Center for Coastal Monitoring and Assessment
Biogeography Program
1305 East West Highway
Silver Springs, MD 20910
301-713-3028 ext. 160
http://biogeo.nos.noaa.gov/products/data/photos/hawaii.shtml

RM Towill Corporation
420 Waikamilo Road, Suite 411
Honolulu, Hawaii 96817
808-842-1133

School of Ocean and Earth Science Technology
University of Hawaii
2525 Correa Road
Honolulu, Hawaii 96822
808-956-7640

United States Geological Survey
Hawaii District Office
677 Ala Moana Boulevard, Suite 415
Honolulu, Hawaii 96813
808-587-2400

Appendix D - Regulatory Takings

D.1 Introduction

At what point does a public agency action constitute a "regulatory taking?"

The law of takings derives from the Fifth Amendment of the U.S. Constitution: "...nor shall private property be taken for public use without just compensation."[178] Most people are familiar with the process of eminent domain where the government acquires private property for public use and compensates the private owner accordingly. In 1922, the United States Supreme Court held that if a government regulation "goes too far" it has the same effect on the property owner as if the government had actually physically appropriated the land.[179] Cases since 1922 have attempted to answer the question, "when does a regulation go too far?"

Recent decisions of the United States Supreme Court help to identify a three-step process that can be used to analyze a regulatory takings claim.[180]

First Step - The first step involves determining if a claim is ripe for review. A regulatory takings claim is not ripe until the government entity charged with implementing the regulations reaches a final decision regarding the application of the regulations to the property at issue.[181] Thus, if there is an appeals process or a variance procedure that a claimant has not gone through, the claim is unlikely to be ripe for review.

Second Step - If the claim is ripe, the reviewing court must then determine whether the government regulation falls into one of the two categories that the Supreme Court has identified as a *per se* takings.[182]

There are two categories of *per se* takings:

1) Physical Invasions - A taking occurs whenever there is a "permanent physical occupation" of the property by the government regardless of how minimal the intrusion or how important the governmental interest at stake.[183]

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[178] Article I, Section 20 of the Constitution of the State of Hawaii states, "private property shall not be taken or damaged for public use without just compensation."
[179] See Pennsylvania Coal Co. v. Mahon, 260 U.S. 393 (1922).
[180] Palazzolo v. Rhode Island, 533 U.S. 606 (2001); Sierra Preservation Council v. Tahoe Regional Planning Agency, 535 U.S. 302 (2002).
[181] Palazzolo, 533 U.S. 606, 618 (2001).
[182] Lucas v. South Carolina Coastal Council, 505 U.S. 1003, 1016 (1992).
[183] This *per se* test was articulated in Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419 (1982).

2) Sacrifice of All Economically Beneficial Use - Here a taking occurs whenever the owner of real property is "called upon to sacrifice all economically beneficial uses in the name of the common good," provided that the regulated activity is not an activity prohibited or constrained already by "background principles" of the State's common law regarding property and nuisance.[184] Justice Scalia in the Lucas case gives us two examples of these nuisance-like activities which would be prohibited, even if no economically beneficial use remained: 1) operating a nuclear generating power plant that sits astride an earthquake fault line; and 2) engaging in a landfill operation that would result in the flooding of others' land.[185]

In *Esplanade Properties, LLC v. City of Seattle*, a case decided by the United States Court of Appeals for the Ninth Circuit, it was held that the public trust doctrine can be part of the State's background principles of common law which may result in the government avoiding liability from a regulatory takings claim even if all economically beneficial use is taken.[186] In Hawaii, beaches are part of the State's public trust doctrine and lost beaches systems, as shown in Figures 1-5 and 1-6, are impacts to public trust resources.

<u>Third Step</u> - The two *per se* tests cover only a rare and very small subset of governmental actions. If a regulation does not fall within either of the *per se* categories (e.g., no physical invasion of property or no economically viable use of the land remains), the reviewing court must then determine whether it meets the test for a regulatory taking established in the case of *Penn Central Transportation Co. v. New York City*.[187] This test involves an ad hoc factual inquiry involving three factors:

1) What is the character of the government action?

2) What is the economic impact of the action?

3) To what extent has the regulation interfered with distinct investment-backed expectations of the owner?

[184] In Lucas, the plaintiff challenged a statewide beachfront setback regulation that was designed in part to "protect life and property." Lucas, at 505 U.S. 1021. While upholding the challenge on other grounds, the Court noted that the plaintiff had not challenged the state's police power to enact the legislation. Lucas at 1009.
[185] Id. at 1029.
[186] Esplanade Properties, LLC v. City of Seattle, 307 F.3d 978 (2002).
[187] Penn Central Transportation Co. v. New York City, 438 U.S. 104, 124 (1978).

D.2 The Penn Central Factors As Applied To Land Use Decisions Aimed At Coastal Management:

D.2.1 Character of the Government Action

Land use decisions, such as zoning, are generally made at the local or county level under the "police power" delegated to the local government by state enabling statutes. The local government may regulate land use for numerous purposes such as for esthetics, traffic control, premature urbanization, natural resource protection, or hazard mitigation. It is this government purpose or "character of the government action" that is an important factor in the authority of the government to regulate land use. Intuitively, actions to protect life and property are more important, and should be given more weight, than those related to the protection of scenic views.

"If there is a hierarchy of interests the police power serves—and both logic and prior cases suggest there is – then the preservation of life must rank at the top."[188] Hazard mitigation, inherent in coastal planning, involves protecting life, property and land from natural disasters such as hurricanes, tsunamis, erosion and flooding. Zoning for the purpose of saving human life involves the highest of public interests and would represent a valid exercise of police power.[189] In cases where zoning regulations merely impair an owner's use of property, the Supreme Court has been especially reluctant to find a compensable taking. A zoning ordinance will not be stricken as violative of due process unless it is "clearly arbitrary and unreasonable, having no substantial relation to the public health, safety, morals or general welfare."[190] The Supreme Court has held that regulation of development in hazardous areas to limit damage from natural hazard events is a proper use of local governments' police powers.[191]

In balancing the competing needs of society versus the individual landowner, courts have upheld zoning regulations aimed at preventing death and damage due to flooding and have not found a taking on the basis that preservation of life and property is a goal of overriding social importance, outweighing the landowner's interest in land development.[192]

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[188] First English v. Los Angeles, 210 Cal. App. 3d 1353, 1370 (1989) discussing a hierarchy of purposes served by zoning regulation and concluding that even lesser public interests have been deemed to be sufficient to justify zoning which diminishes, without compensation, the value of individual properties.
[189] Id.
[190] Moore v. East Cleveland, 431 U.S. 494, 495 (1977).
[191] See Dolan v. City of Tigard, 512 U.S. 374, 386-87 (1994) (holding that regulation of floodplains to prevent flooding is a legitimate public purpose).
[192] First English v. Los Angeles, 210 Cal. App. 3d 1353, 1371 (1989).

D.2.2 Economic Impact of the Action

The economic impact of a land use restriction requires a court to weigh public interests against the private owner's interest. The Supreme Court has determined that as part of assessing the economic impact of a land use regulation on an individual landowner, a court must consider that the individual owner will also share in the benefits of the city's exercise of it police power.[193] "In assessing the fairness of the zoning ordinances, these benefits must be considered along with any diminution in market value that appellants might suffer."[194] On balance, the court is likely to find that the public benefits that land use restrictions confer far exceed the private costs they impose on individual property owners, especially after factoring in the public benefits the private owner shares.[195]

D.2.3 Interference With Distinct Investment-Backed Expectations Of The Owner

Initially, a generalization can be made that the earlier in the development process a land use restriction is made, the less likely it will approach a taking. That is because as the land becomes more developed, both the economic impact of a regulatory action and the investment-backed expectations of the landowner increase. One way of looking at investment back expectations is to view them as the time and money an individual owner has currently invested in his property. As Professor Mark Cordes notes in his article;

> The protection of land investment is most reasonably expected, however, when based upon actual development expenditures rather than speculation on future uses. Where a landowner has actually spent money developing land, there is a strong public policy that the landowner can reasonably expect the investment to be protected; otherwise incentives for the development of land, critical to our economic well-being, are jeopardized.[196]

Since the *Penn Central* case was decided in 1978, the Supreme Court has done little to define what actually constitutes an "investment backed expectation".[197] What we do know, is that the Court has indicated that it is grounded in notions of "justice and fairness", that expectations of "profit" enter into the equation, and that the expectation must be more than a "unilateral expectation or an abstract need."[198] Additionally, the Court has replaced its original reference to "distinct investment backed expectations" to

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[193] Agins v. City of Tiburon, 447 U.S. 255 (1980).
[194] Id. at 262.
[195] First English v. Los Angeles, 210 Cal. App. 3d 1353, 1371 (1989).
[196] *See* Mark W. Cordes, Article: The Public/Private Balance In Land Use Regulation, 1998 Det. C.L. Rev. 681, 696 (1998).
[197] *See* Lynda J. Oswald, Article: Cornering the Quark: Investment-Backed Expectations And Economically Viable Uses In Takings Analysis, 70 Wash. L. Rev. 91,106 (1995).
[198] Id.

"reasonable investment backed expectations" in subsequent cases.[199] Therefore, time and money spent to advance a project that is clearly unreasonable may not be fully valued by Courts. For example, money spent for a project that is against general and community plans and the existing uses in the immediate and adjacent area may not be valued as highly as expenditures for a project in conformance with planning documents and the surrounding area.

D.3 Relationship of this Manual with Regulatory Takings Issues

This manual deals with hazard mitigation and reducing the risks from erosion, flooding, hurricanes and tsunamis for all stages of development. These hazards overlap along the coast and planning for one hazard will reduce the risk from the other hazards. A major portion of this manual concentrates on erosion. Coastal erosion can increase the risk of flooding by causing flood zones to migrate inland (Figure 1-9). Furthermore, the erosion zone, as defined in this manual, is the area along the coast with the most intense and varied forces of nature (Figure 3-1).

In Figure D-1, some common objectives that a government agency may use to regulate land ("Character of the Government Action") are displayed in a hierarchy and compared with the impact on the landowner. This diagram summarizes graphically many of the key points that are listed below:

1) While the government may regulate land use for esthetic reasons or to protect scenic views, these lesser but legitimate government interests are sometimes outweighed by the economic impact on the landowner.

2) Hazard mitigation to protect life gives the government the greatest authority to regulate land use and is on the top of the scale in terms of importance.[200] Hazard mitigation to protect life should outweigh the landowner's right to develop property, no matter what stage of development a project is in.

3) Since hazard mitigation is at the top of the scale, agencies should make the greatest effort to implement scientifically based hazard mitigation measures even if it requires a trade off in other less important areas (e.g., in order to implement a large coastal setback for hazard mitigation, a variance from a side or front setback may be needed which will likely impact esthetic values.)

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[199] Id. at 107. For additional discussion on investment backed expectations, and the relevance of a pre-existing regulation, see the discussion of Justices O'Conner and Scalia in Palazzolo, 533 U.S. at 634-637.

[200] First English Evangelical Lutheran Church of Glendale v. County of Los Angeles, California, 482 U.S. 304, 327, discussion by Rehnquist on safety regulations; First English v. County of Los Angeles, 210 Cal. App.3d 1353, 1371-1372, holding that flood regulations were enacted for safety purposes and insulated the agency from a takings claim; First English v. County of Los Angeles, 493 U.S.1056, writ of certiorari to U.S. Supreme Court denied.

4) A distinction is made between hazard mitigation for the protection of life versus property. Flood regulations are typically considered as related to the protection of life *(First English v. Los Angeles and Lucas).* Erosion regulations are sometimes considered to be unrelated to hazard mitigation *(Lucas).* This is a mistake since erosion increases the risk of flooding (Figure 1-9). Furthermore, the erosion zone is the area with the most intense flood and wave inundation forces (Figure 3-1). While long-term steady erosion, by itself, may not threaten life, it will threaten property. However, short-term storm induced erosion will threaten life and property. The erosion zone in this manual factors long term erosion and short term storm erosion events (Chapter 4). Finally, many of the risks from flooding are able to be mitigated with the proper construction techniques, while mitigation for erosion risks cannot be addressed solely by construction techniques and thus needs to be addressed during the siting stages of development.

5) Due to the *Esplanade* case, regulations that deal with natural resource protection and preservation of the public trust resources such as the beach system give an agency greater authority than previously believed. In certain cases, this authority may outweigh landowner property rights, even for the later stages of development.

6) The landowner's rights grow with each stage of development that a project passes through (Figure 2-5). In general, the economic impact and interference with investment backed expectations of a siting regulation is greatest at the later stages of development (e.g., infill or home construction phase – Stage 7 versus district classification or zoning phase – Stages 1 or 3). Due to the varying impact, land use hazard mitigation strategies should be adjusted for the different development stages to account for fairness and practicality factors, while maintaining technically based standards.

7) Due to the points raised in paragraph 6, hazard mitigation should be addressed as early as possible in the development hierarchy, although the agencies will still have considerable authority to protect life and property even at later stages of development. Nevertheless, hazard mitigation issues related to siting should not be ignored and passed down the development chain as this will place unnecessary burden on landowners.

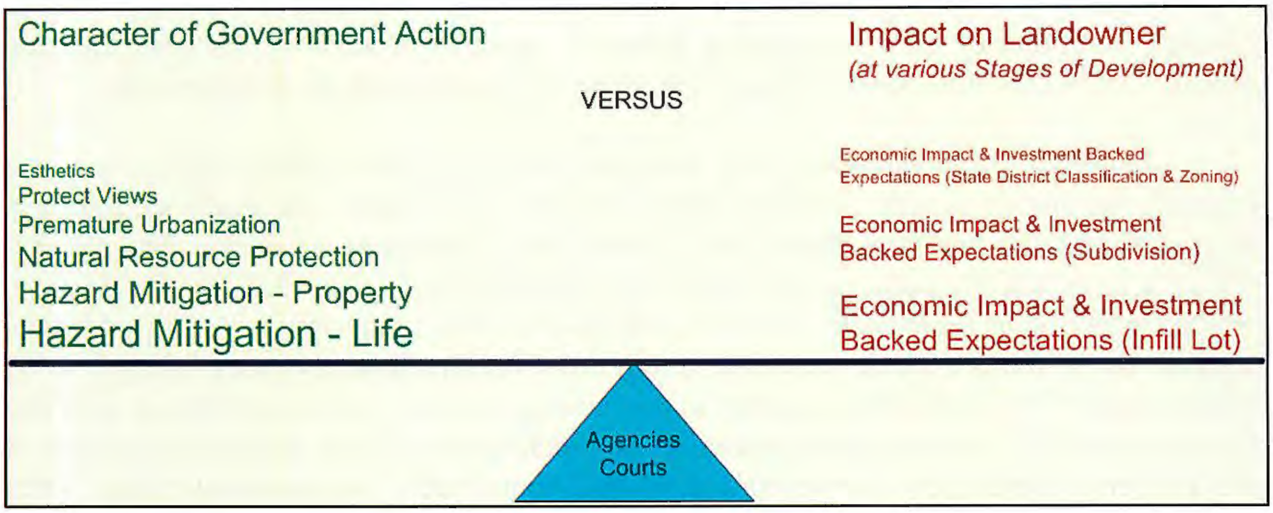

Figure D-1 – Comparison of Character of the Government Action Versus Impact on the Landowner - The size of the text reflects relative importance. For any land use decision, the agencies or courts must weigh the character or purpose of the regulatory conditions with the economic impact and the investment backed expectations of the landowner. For example, government action with regard to hazard mitigation is given more weight than lesser objectives related to esthetics. The impact on the landowner of a siting or setback regulation will be dependant on many factors, a key being the stage of development that the project is in. With each stage of development that a project passes through, the economic impact, as well as the investment backed expectations of the landowner will grow (See Figure 2-5). As an example, a government regulation that mitigates the hazards to property will be given great weight and is likely to be constitutionally valid when compared to the economic impact and investment backed expectations of a landowner at the State district or zoning stage. However, a greater challenge may result if the same regulatory restrictions are imposed on the landowner at the infill lot stage.

D.4 "Takings" Legislation

Many states, as well has the U.S. Congress, have considered various forms of "takings" legislation. Under the proposed legislation, local governments would be forced to pay landowners when a new regulation partially devalues property (usually somewhere between 10 and 50 percent). Compensation statutes would require payment to property owners who suffer diminution in value even if a court would not find that a Constitutional taking had occurred.

According to critics of these statutes, there are several problems inherent in this kind of legislation.[201] First, compensation statutes switch the focus from the character of the government action to the impact of the regulation on the individual land owner. Traditionally, the inquiry for land use regulations has been whether the regulation promotes the public health, safety, welfare or morals.[202] Compensation statutes, on the other hand, focus exclusively on the loss of value to the individual property owner and

[201] See Lynda J. Oswald, Article: Property Rights Legislation and the Police Power, 37 Am. Bus. L.J. 527 (2000).
[202] Id. at 549.

ignore the validity of the governmental action.[203] Another problem is that compensation statutes fail to take into consideration what stage of development the property is in.

Although this manual does not advocate a compensation statute, there is merit in providing guidance on when compensation should be considered. The guidance will help to ensure that: (i) compensation is not provided to implement measures that are well within a jurisdictions police power and (ii) compensation is provided for situations in which there is a legitimate issue of fairness or for situations in which political considerations require a compensation tool in order for a technically based measure to be implemented. The term compensation in this manual refers to measures that can alleviate economic burden from the implementation of a technical standard, including purchase of the property, purchase of development rights, transferable development rights, open space incentives, or a system of compensating variances. Many of these measures do not require the expenditure of public funds.

Compensation statutes typically require payment or other compensation to landowners when a land use regulation reduces value by 10-50%. However, these provisions fail to consider the purpose of the government action or the stage of development that a project is in. This manual deals with the government objective of hazard mitigation, which provides an agency considerable authority to regulate land use (Figure D-1). In addition, this manual attempts to implement the measures at the earliest stages of development, thus minimizing the economic impact on landowners.

While the following percentages can be adjusted by the agencies depending on different circumstances, it is felt that any compensation tool should not be considered until the land has been devalued by 50% or greater. To offer compensation beforehand could be too burdensome on government agencies attempting to mitigate the risks of coastal hazards. Furthermore, compensation would be offered considerably before it would be constitutionally required.

This manual also recommends that if devaluation reaches 75% or greater, compensation tools should seriously be considered, even though they may not be constitutionally required. This would be especially so for the later stages of development (e.g., subdivision (Stage 4) versus State district classification or zoning (Stages 1 or 3)). The compensation tools would increase the chance that a technically based setback can be implemented for difficult land use decisions or for cases where the mitigation of coastal hazards has been addressed very late in the development process.

For the infill lot stage (Stage 7), it is recommended that the property rights issue be addressed by utilizing minimum buildable area provisions that are discussed in Sections 11.1 and 11.3. These provisions can be crafted in a number of imaginative ways

[203] Id.

to maximize the safety buffer while accounting for economic use and the investment backed expectations of the landowner.

D.5 Measuring Devaluation of Property

It is important to discuss the devaluation of property for the purpose of measuring when the compensation thresholds are likely to be reached.

With early planning and utilizing many of the strategies in this manual, significant reduction in the risks from hazards can be obtained for most areas with little reduction in the value of the properties. For example, innovative and flexible subdivision design can allow implementation of scientifically based coastal setbacks while allowing for almost the same number of lots to be created (Chapter 8).

It is also important that in evaluating devaluation, a knowledgeable and informed buyer should be considered. Thus, land and property should be valued based on the presence or absence of hazard mitigation measures. For example, a large elaborate house built close to the beach but subject to erosion and flooding risks may, in the long run, be worth less than a more modest home that is able to survive the forces of nature. The proper disclosure of hazard risks will increase the likelihood that hazard mitigation measures are properly valued (Chapter10).

Appendix E - Glossary

The following glossary is provided to explain the terms and acronyms used in this guidebook. Many of the terms are derived from definitions in the FEMA Coastal Construction Manual. For some terms, additional explanation is provided to place the term within Hawaii's regulatory framework. In addition, some definitions are provided to clarify specific concepts developed in the guidebook.

A zone - Under the National Flood Insurance Program, the area subject to inundation by the 100-year flood where wave action does not occur or where waves are less than 3 feet high (designated Zone A, AE, A1-A30, A0, AH, or AR on a Flood Insurance Rate Map (FIRM)). In Hawaii, the AE Zones are generally determined where the depth of water from a 100-year event (as determined from tsunami and/or hurricane data) is less than 4 feet.

BFE - Base Flood Elevation

Base flood - Flood that has as 1-percent probability of being equaled or exceeded in any given year. Also known as the 100-year flood.

Base Flood Elevation - Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum or the North American Vertical Datum. The Base Flood Elevation is the basis of the insurance and floodplain management requirements of the National Flood Insurance Program.

Breakaway wall - Under the National Flood Insurance Program, a wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building or supporting foundation system. Breakaway walls are required by the National Flood Insurance Program regulations for any enclosures constructed below the Base Flood Elevation beneath elevated buildings in Coastal High Hazard Areas (also referred to as V zones). In addition, breakaway walls are recommended in areas where flood waters flow at high velocities or contain ice or other debris.

Building codes - Refers to standards for construction such as the Uniform Building Code, International Building Code, or the American Society of Civil Engineers Standard for Wind Load. Although the counties follow the UBC, they may eventually follow the IBC. The reader should check with the respective county building department (Table 2-1, Row 8) to determine the relevant building code, or recent amendments that may be applicable for a specific project.

Bulkhead - Wall or other structure, often of wood, steel, stone, or concrete, designed to retain or prevent sliding or erosion of the land. Occasionally, bulkheads are used to protect against wave action.

Coastal A zone - The portion of the Special Flood Hazard Area landward of a V zone or landward of an open coast without mapped V zones in which the principal sources of flooding are astronomical tides, storm surge, seiches, or tsunamis, not riverine sources. The flood forces in coastal A zones are highly correlated with coastal winds or coastal seismic activity. Coastal A zones may therefore be subject to wave effects, velocity flows, erosion, scour, or combinations of these forces. See A zone and Non-coastal A zone. (Note: the National Flood Insurance Program regulations do not differentiate between coastal A zones and non-coastal A zones.)

Coastal High Hazard Area - Under the National Flood Insurance Program, an area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave action from storms or seismic sources. On a Flood Insurance Rate Map, the Coastal High Hazard Area is designated Zone V, VE, or V1-V30. These zones designate areas subject to inundation by the base flood where wave heights or wave runup depths are greater than or equal to 3.0 feet. In Hawaii, the VE Zones are generally determined where the depth of water from a 100-year event (as determined from tsunami and/or hurricane data) is greater than 4 feet.

Debris line - Line left on a structure or on the ground by the deposition of debris. A debris line often indicates the height or inland extent reached by flood waters.

Design flood - The greater of either: (1) the base flood or (2) the flood associated with the flood hazard area depicted on a community's flood hazard map, or otherwise legally designated.

Design flood elevation - Elevation of the design flood, or the flood protection elevation required by a community, including wave effects, relative to the National Geodetic Vertical Datum, North American Vertical Datum, or other datum.

Erosion - Under the National Flood Insurance Program, the process of the gradual wearing away of land masses. In general, erosion involves the detachment and movement of soil and rock fragments, during a flood or storm or over a period of years, through the action of wind, water, waves or other geologic processes.

Erosion analysis - Analysis of the short and long-term erosion potential of soil or strata, including the effects of flooding or storm surge, moving water, wave action, and the interaction of water and structural components. See Chapter 4 and Figure 4-4 for a standard to conduct the erosion analysis.

Erosion zone - For the purposes of this manual, an area that extends from the shoreline to a distance inland equal to the erosion rate times the life expectancy of certain structures plus a storm and design buffer. See Figures 3-1, Chapter 4 and Table 4-1.

FEMA - Federal Emergency Management Agency

FEMA CCM - FEMA's Coastal Construction Manual

FIRM - Flood Insurance Rate Map

500-year flood - Flood that has a 0.2-percent probability of being equaled or exceeded in any given year.

Flood elevation - Height of the water surface above an established elevation datum such as the National Geodetic Vertical Datum, North America Vertical Datum, or mean sea level.

Flood Insurance Rate Map - Under the National Flood Insurance Program, an official map of a community, on which the Federal Emergency Management Agency has delineated both the special hazard areas and the risk premium zones applicable to the community. (Note: The latest FIRM issued for a community is referred to as the effective FIRM for that community.)

Flood insurance study - Under the National Flood Insurance Program, an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluation, and determination of mudslide (i.e., mudflow) and/or flood-related erosion hazards in a community or communities. (Note: The National Flood Insurance Program regulations refer to Flood Insurance Studies as "flood elevation studies.")

Flood zone - For the purposes of this manual, the area that coincides with the A, AE and X zones. See Figure 3-1 and Chapter 4.

Freeboard - Under the National Flood Insurance Program, a factor of safety, usually expressed in feet above a flood level, for the purposes of floodplain management. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than the heights calculated for a selected size flood and floodway conditions, such as the hydrological effect of urbanization of the watershed.

Frontal dune - Ridge or mound of unconsolidated sandy soil, extending continuously alongshore landward of the sand beach and defined by relatively steep slopes abutting markedly flatter and lower regions on each side.

Hardening - the process of fortifying the shoreline with hard structures such as seawalls and stone revetments.

Hazard zone - As used in this manual, the area that the individual county decides should have restrictions on development based on undue risks from coastal hazards. For most areas, the hazard zone would coincide with the erosion zone. Where there is high risk due to wave action, the agency may treat the erosion and wave (V-VE) zone as part of the hazard zone. In the rarest circumstances, the hazard zone could conceivably incorporate the erosion, wave (V-VE) and flood (A-AE) zones. See Figure 3-1 and Section 5.2.2.

Hurricane - Tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 miles per hour or more and blow in a large spiral around a relatively calm center or "eye." Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

Hurricane clip or strap - Structural connector, usually metal, used to tie roof, wall, floor, and foundation members together so that they can resist wind forces.

Hydrodynamic loads - Loads imposed on an object, such as a building, by water flowing against and around it. Among these loads are positive frontal pressure against the structure, drag effect along the sides, and negative pressure on the downstream side.

Hydrostatic loads - Loads imposed on a surface, such as a wall or floor slab, by a standing mass of water. The water pressure increases with the square of the water depth.

IBC – International Building Code

Inland zone - For the purposes of this manual, the area that is inland of the A and X zones (the limit of the 500-year flood). See Figure 3-1 and Chapter 4

Loads - Forces or other actions that result from the weight of all building materials, occupants and their possessions, environmental effects, differential movement, and restrained dimensional changes. Permanent loads are those in which variations over time are rare or of small magnitude. All other loads are variable loads.

Lowest floor - Under the National Flood Insurance Program, the lowest floor of the lowest enclosed area (including basement) of a structure. An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement is not considered a building's lowest floor, provided that the enclosure is not built so as to render the structure in violation of National Flood Insurance Program regulatory requirements.

Lowest horizontal structural member - In an elevated building, the lowest beam, joist, or other horizontal member that supports the building, Grade beams installed to support vertical foundation members where they enter the ground are not considered lowest horizontal structural members.

Mitigation - Any action taken to reduce or permanently eliminate the long-term risk to life and property from natural hazards.

N_a - Near source factor used in determination of seismic coefficients to determine total design base shear in Seismic Zone 4 (Hawaii County) related to the proximity of a building or structure to known faults with specific magnitudes and slip rates.

N_v - Near source factor used in determination of seismic coefficients to determine shear in a given direction in Seismic Zone 4 (Hawaii County) related to the proximity of a building or structure to known faults with specific magnitudes and slip rates.

NFIP - National Flood Insurance Program

National Flood Insurance Program - Federal program created by Congress in 1968 that makes flood insurance available in communities that enact and enforce satisfactory floodplain management regulations.

100-year flood - See Base flood.

Primary frontal dune - Under the National Flood Insurance Program, a continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the primary frontal dune occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

Revetment - Facing of stone, cement, sandbags, or other materials placed on an earthen wall or embankment to protect it from erosion or scour caused by flood waters or wave action.

Scour - Removal of soil or fill material by the flow of flood waters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.

Seawall - Solid barricade built at the water's edge to protect the shore and to prevent inland flooding and erosion.

SFHA – see Special Flood Hazard Area

Shoreline hardening – see Hardening

Shoreline retreat - Progressive movement of the shoreline in a landward direction caused by the composite effect of waves and storms considered over decades and centuries (expressed as an annual average erosion rate). Shoreline retreat considers the horizontal component of erosion and is relevant to long-term land use decisions and the siting of buildings.

Special Flood Hazard Area - Under the National Flood Insurance Program, an area having special flood, mudslide (i.e., mudflow) and/or flood-related erosion hazards, and shown on a Flood Hazard Boundary Map or Flood Insurance Rate Map as Zone A, AO, A1-A30, AE, A99, AH, V, V1-V30, VE, M or E.

Stillwater elevation - Projected elevation that flood waters would assume, referenced to the National Geodetic Vertical Datum, North American Vertical Datum, or other datum, in the absence of waves resulting from wind or seismic effects.

Storm surge - Rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface.

Substantial damage - Under the National Flood Insurance Program, damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial improvement - Under the National Flood Insurance Program, any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the start of construction of the improvement. This term includes structures which have incurred substantial damage, regardless of the actual repair work performed. The term does not, however, include either: (1) any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions, or (2) any alteration of a "historic structure," provided that the alteration will not preclude the structure's continued designation as a "historic structure."

Tsunami - Great sea wave produced by submarine earth movement or volcanic eruption.

UBC – Uniform Building Code

V zone - See Coastal High Hazard Area.

VE zone – Coastal High Hazard Areas where the Base Flood Elevations have been determined through a detailed study.

Wave runup - Rush of wave water up a slope or structure.

Wave runup depth - Vertical distance between the maximum wave runup elevation and the eroded ground elevation.

Wave runup elevation - Elevation, referenced to the National Geodetic Vertical Datum or other datum, reached by wave runup.

Wave zone - For the purposes of this manual, the area that coincides with the V, VE, or V1-V30 zone or Coastal High Hazard Area. See Figure 3-1 and Chapter 4.

X zone - Under the National Flood Insurance Program, areas where the flood hazard is less than that in the Special Flood Hazard Area. Shaded X zones shown on recent Flood Insurance Rate Maps (B zones on older maps) designate areas subject to inundation by the 500-year flood. Unshaded X zones (C zones on older Flood Insurance Rate Maps) designate areas where the annual probability of flooding is less than 0.2 percent.