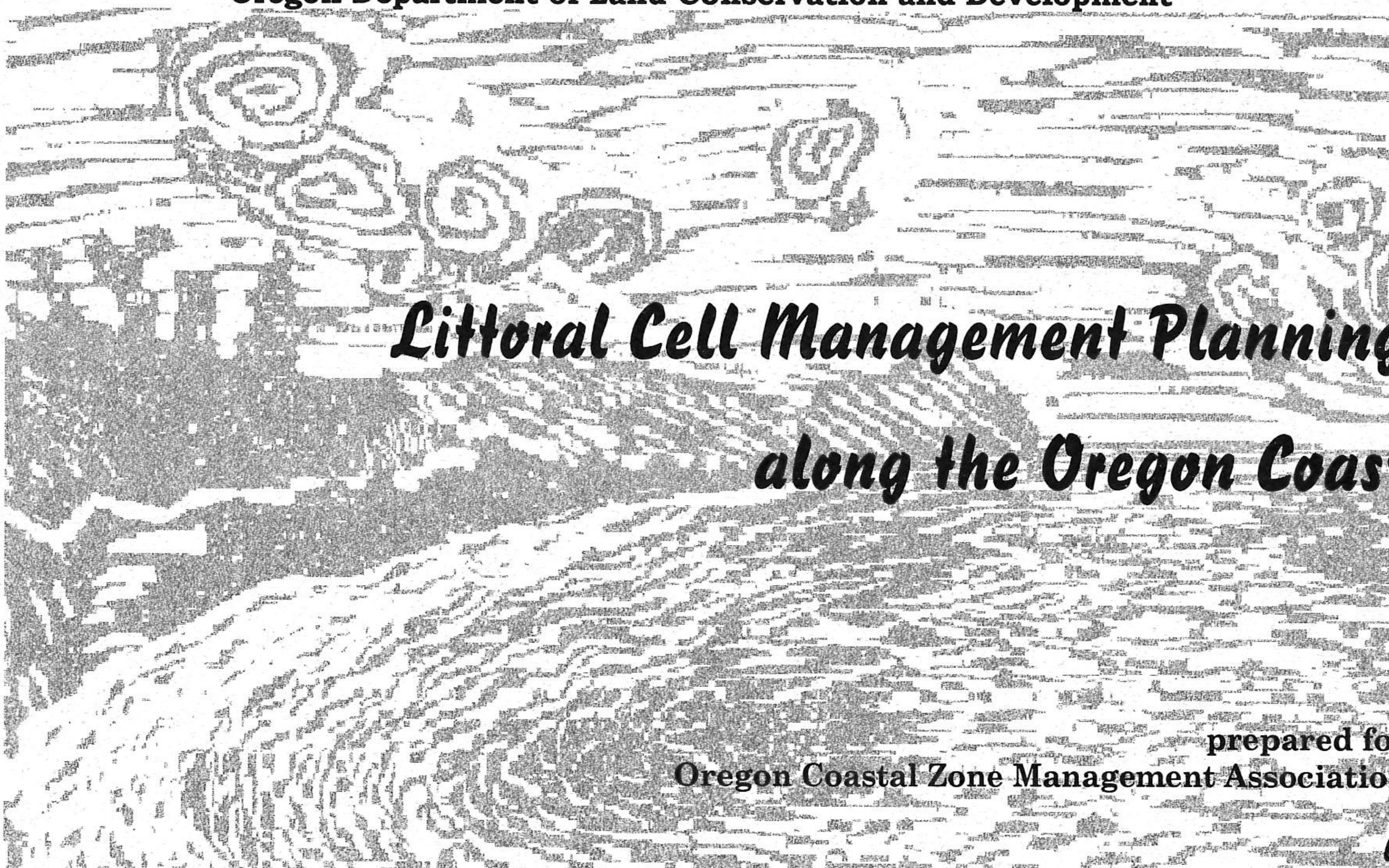
Oregon Department of Land Conservation and Development



Littoral Cell Management Planning along the Oregon Coast

prepared for
Oregon Coastal Zone Management Association

by
Shoreland Solutions

December 1995

Littoral Cell Management Planning

along the Oregon Coast

report to the

Oregon Department of Land Conservation and Development

prepared for

Oregon Coastal Zone Management Association
313 SW 2nd Avenue, Suite C
Newport, Oregon 97365

by

Shoreland Solutions
P.O. Box 1046
Newport, Oregon 97365

PREFACE

The littoral cell management planning project is the latest in a series of projects conducted by the Oregon Department of Land Conservation and Development (DLCD) as part of their five year '309 strategy' to improve coastal natural hazards policy, assessment, and awareness in Oregon. The report which follows represents the first phase of this project. The objective of the second phase of this project is to apply the concepts described in the report to develop and implement a pilot littoral cell management plan along the Oregon coast.

This project builds upon previous year's efforts carried out as part of the 309 strategy. These include support of the Coastal Natural Hazards Policy Working Group, development and implementation of a model chronic hazards mapping methodology along a portion of the central Oregon coast, development of detailed content standards to improve the quality of site-specific hazard reports, and an Appraisal of Coastal Hazards Alleviation Techniques with special emphasis on the Oregon coast.

For further information on DLCD's 309 strategy and its work products contact the
Oregon Department of Land Conservation and Development
1175 Court Street NE
Salem, OR 97310
(503) 373-0050

Funding for this work was provided by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under Section 309 of the Coastal Zone Management Act through the Oregon Department of Land Conservation and Development.

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December 1995

Introduction

During the late 1970's and early 1980's Oregon established policies aimed at reducing risks to new and existing development from chronic coastal natural hazards. Recently, several reports have evaluated the effectiveness of these policies in light of increased pressure for development as well as advances in scientific understanding. These reports include the 1992 Assessment of Coastal and Ocean Resources Planning Issues and Management Capability and the 1994 Recommendations of the Coastal Natural Hazards Policy Working Group, among others.[5,8,16,17] They concluded that existing policies and procedures need to be improved. One action recommended to improve Oregon's system of oceanfront development and shore protection decision-making is for chronic hazard alleviation needs to be assessed and addressed at the scale of individual littoral cells or subcells.

A move towards area-wide hazards management is appealing for a variety of reasons:

- Hazard assessment is more consistent in quality when it is carried out on an area-wide scale;
- Hazard alleviation is more effective and less expensive when it is addressed at the same scale which factors affecting shoreline stability are operative;
- The potential for adverse impacts and cumulative effects are minimized because there is an increased likelihood that these considerations will enter into the decision-making process; and
- Decision-making is more timely and predictable because interagency and intergovernmental coordination is enhanced.

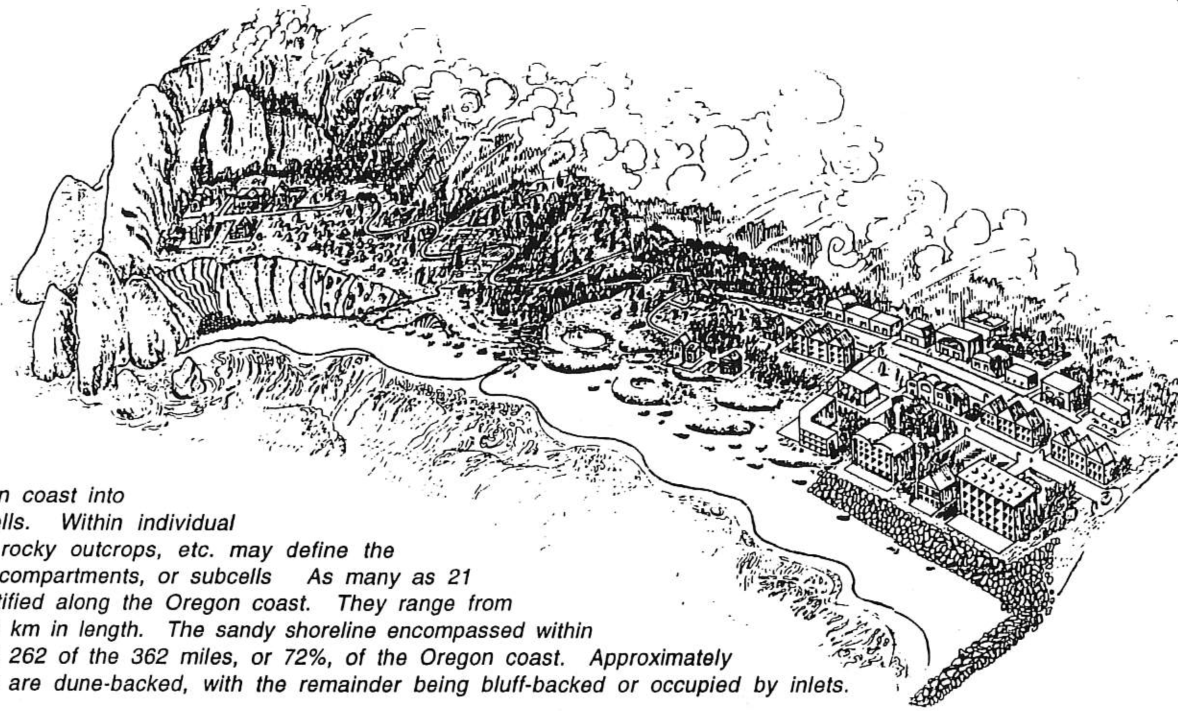
Thus, littoral cell management planning has the potential to improve the public and private sectors ability to locate new development away from hazardous areas and to minimize threats to existing development, while at the same time improving both resource protection and economic opportunities.

'Chronic' Coastal Natural Hazards

The Oregon coast is subject to a variety of natural hazards associated with processes that occur across a range of spatial and temporal scales. Chronic hazards are those which are local in scale and scope. Along dune-backed shorelines chronic hazards include; ocean flooding; beach and dune erosion; and sand inundation. Along bluff-backed shorelines, bluff recession and landsliding/slumping fall into the chronic hazard category. Human activities may be a concern in both types of shoreline setting.

In contrast to chronic hazards, catastrophic hazards are regional in scale and scope. Cascadia Subduction Zone earthquakes, and the ground shaking, subsidence, landsliding, liquefaction, and tsunami that accompany them, fall into the catastrophic hazard category.

Being local in nature, the threats to human life and property that arise from chronic hazards are generally less severe than those associated with catastrophic hazards. However, their wide distribution and frequent occurrence make chronic hazards a more immediate concern.



'Littoral Cells'

Headlands divide the Oregon coast into compartments, or littoral cells. Within individual littoral cells, inlets, jetties, rocky outcrops, etc. may define the boundaries of even smaller compartments, or subcells As many as 21 littoral cells have been identified along the Oregon coast. They range from less than 10 km to over 100 km in length. The sandy shoreline encompassed within these cells represents about 262 of the 362 miles, or 72%, of the Oregon coast. Approximately 45% of these sandy shores are dune-backed, with the remainder being bluff-backed or occupied by inlets.

Ideally, littoral cells or subcells define closed compartments in terms of 'sand supply'. This is because the headlands restrict transfers of sediment to exchanges within individual littoral cells. These internal exchanges are typically described in terms of contributions to or losses from the littoral cell 'sediment budget'. Thus, erosion or accretion along any given segment of shoreline reflects the balance of the budget - negative or positive respectively.

Rivers, bluffs, dunes, and the inner shelf have been identified as potential 'sources' of sediment within Oregon coast littoral cells. Bays, dunes, the offshore, dredging, and mining have been identified as potential 'sinks'. It is known that combinations of sources and sinks, as well as absolute budget balances, differ markedly between individual cells along the Oregon coast. However, detailed sediment budgets of individual cells do not exist.

These concepts have important management as well as scientific implications. For example, they suggest that efforts to alleviate hazards along one segment of shoreline have the potential to adversely impact other segments of shoreline. Further, they suggest that maintaining an adequate littoral cell sand supply is an important objective. This is because maintenance of an adequate sand supply, and hence a wide sandy beach, not only provides benefits from the standpoint of hazard alleviation, but it also enhances recreational, scenic, and in turn, economic opportunities.

While the concept of a littoral cell management plan is appealing, the specifics of such a plan have never been described. With this in mind, this document outlines a framework for littoral cell management planning along the Oregon coast. This is accomplished by providing answers to the following questions:

- **What is a littoral cell management plan?;**
- **What does littoral cell management planning involve?**; and
- **Who develops and implements a littoral cell management plan?.**

The framework for littoral cell management planning outlined in this document is designed to serve as a guide to city and county planners, state and federal regulators and resource managers, coastal scientists, property owners, business leaders, community activists, and others who might be interested in developing and implementing such a plan. The framework is intended to be flexible enough to accommodate the broad range of community needs and capabilities found along the Oregon coast.

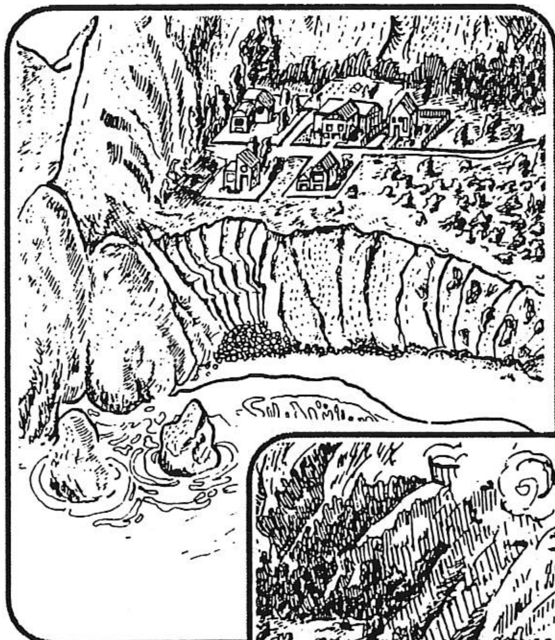
Recommendations contained herein are based on a review of literature encompassing the topics of special area management planning and coastal natural hazards alleviation. They also result from discussions with city and county planners, state and federal agency representatives, engineers, geologists, geographers, oceanographers, vegetation specialists, and oceanfront property owners. These discussions took place at meetings held at five different locations - Corvallis, Portland, Cannon Beach, Newport, and Bandon- during the month of September 1995. Views expressed during these discussions are summarized in an appendix to this document. Also, please note that side bars are used liberally throughout this document to provide additional background and further details.

Oregon's existing system of oceanfront development and shore protection decision-making.

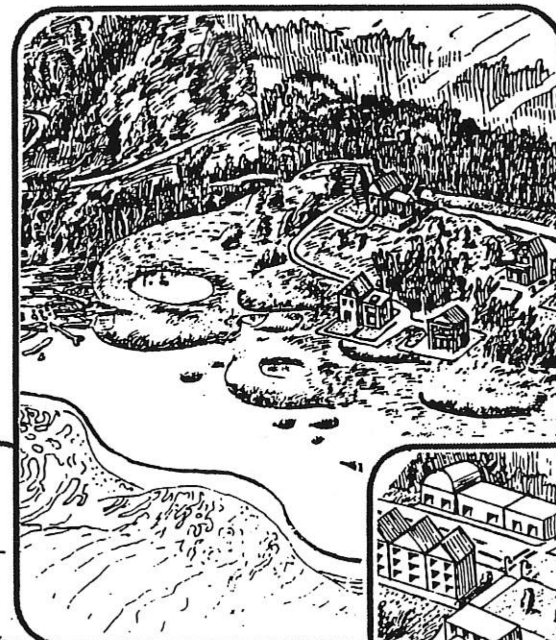
All new oceanfront development is regulated at the local level through comprehensive plans and zoning ordinances acknowledged to comply with Oregon's Statewide Planning Goals. Specifically, Goals 7, 17, and 18 contain provisions related to coastal natural hazards management. Goal 18, for example, prohibits development on beaches, active foredunes, or other foredunes which are conditionally stable and that are subject to ocean undercutting or wave overtopping, and on interdune areas (deflation plains) that are subject to ocean flooding.

Hazard alleviation for existing development is regulated principally at the state level, where two agencies share responsibilities. The Ocean Shore Law (ORS 390.605 -390.770), also known as the "Beach Bill", requires that a permit be obtained from the Oregon Parks and Recreation Department (OPRD) for all "beach improvements" west of a surveyed beach zone line. The Removal/Fill Law and implementing regulations (ORS 196.800 - 196.990) contain specific standards and requirements for rip rap and other bank and shore stabilization projects. Administered by the Oregon Division of State Lands (ODSL), jurisdiction extends from the Pacific Ocean shore to the line of established upland vegetation or the highest measured tide, whichever is greater. Permits issued by these agencies are required to be consistent with the Statewide Planning Goals and corresponding provisions of local comprehensive plans.

Various combinations of physical and social settings found along the Oregon coast.



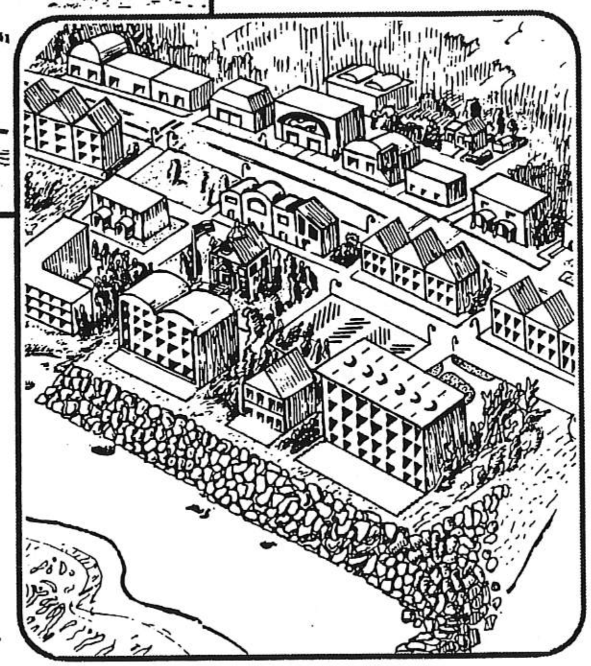
<-- Low density residential use along bluff-backed shorelines



<-- Low density residential use along dune-backed shorelines

Recreational use along bluff-backed shorelines -->

Commercial use along altered dune-backed shorelines -->



What is a littoral cell management plan?

A littoral cell management plan is a comprehensive, integrated, area-wide hazards management strategy unique to different physical and social settings found along the Oregon coast. It is focused on the reduction of risk to new and existing oceanfront development from chronic coastal natural hazards. A littoral cell management plan should include: littoral cell inventories; a chronic hazards management strategy; and implementing mechanisms.

• The **Littoral Cell Inventory** is a collection of information describing physical, biological, and cultural characteristics within a given littoral cell or subcell. This inventory information, which can be in map, database, and text formats, forms the basis for decision-making.

• The **Chronic Hazards Management Strategy** is a description of preferred management measures and the policies and procedures needed to implement them. Two parts of an overall chronic hazards management strategy can be identified:

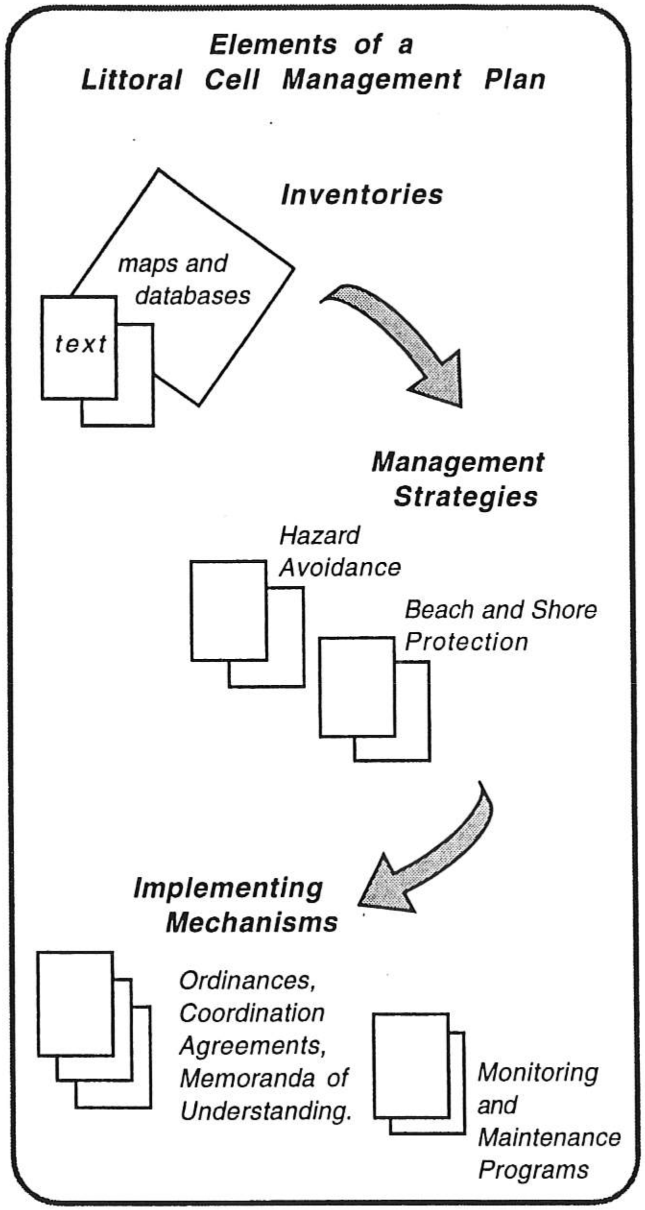
- The **hazard avoidance strategy**, which focuses on policies and procedures pertaining to the siting and design of new development; and

- The **beach and shore protection strategy**, which focuses on policies and procedures pertaining to hazard alleviation for existing development.

Together, theses two strategies form the substance of a littoral cell management plan.

• **Implementing Mechanisms** include local ordinances, coordination agreements, memoranda of understanding, or other similar types of documents which adopt policies and procedures prescribed in the management strategy. These materials, together with monitoring and maintenance programs, are needed to ensure the success of a littoral cell management plan.

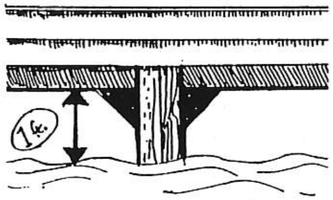
These basic elements of a littoral cell management plan are further detailed in subsequent sections of this document.

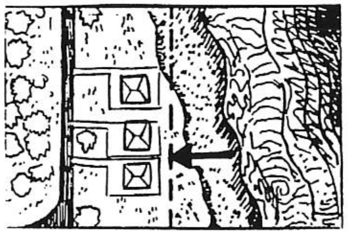


Hazard Avoidance Options

Generally speaking, hazard avoidance options are techniques which can be used to reduce potential risk by influencing the location, elevation, and design of new structures and infrastructure.[5] Although typically applied to new development, hazard avoidance options may also be incorporated into the remodeling and repair of existing development. Examples of hazard avoidance options include:

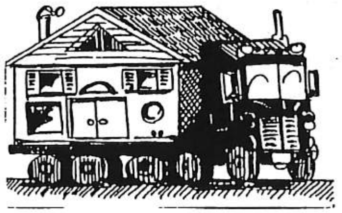
- ***Siting, design and construction standards.*** *This option encompasses standards governing aspects of development including site preparation (e.g. vegetation removal, excavation, drainage controls) and building design and construction (e.g. foundation, frame and roof design details, types of construction materials). FEMA's 100 year 'V-zone' construction standards are one example of measures of this type, many of which are already incorporated into state and/or local building codes and local zoning ordinances.*





- ***Oceanfront construction setbacks.*** *This option encompasses requirements to locate new development some minimum horizontal distance landward of an identified hazard area. Most of Oregon's coastal cities and counties employ some form of oceanfront construction setback.*

- ***Relocation and land acquisition programs.*** *This option encompasses incentive programs, which typically take the form of subsidies intended to discourage the location of habitable structures in potentially hazardous areas or to encourage the relocation of existing development. Such programs are not currently commonplace in Oregon.*



Educational programs, Natural resource protection laws, *and* ***Zoning controls and infrastructure planning*** *might also be considered under the category of hazard avoidance options.[5]*

What does littoral cell management planning involve?

Littoral cell management plans are developed through a three step planning process carried out in two phases. The three basic steps **-inventory, analysis, and implementation-** are repeated during both phases of the planning process. However, each step in the planning process involves different activities and results in different products.

The objective of the first phase of the planning process is to develop and implement a hazard avoidance strategy. This involves identifying chronic coastal natural hazards within a littoral cell or subcell, assessing potential risks from these hazards, formulating policies to avoid unacceptable risks, and prescribing measures that can be taken to implement these policies.

The objective of the second phase of the planning process is to develop and implement a beach and shore protection strategy. This involves identifying potentially applicable beach and shore protection techniques, assessing the positive and negative impacts of these techniques, formulating policies regarding preferred alternatives, and prescribing measures that can be taken to implement these policies.

Phase I: Hazard Avoidance

Inventory. The first step in the planning process is to collect information describing physical and human factors affecting chronic shoreline stability within a given littoral cell or subcell. This information makes up the **physical inventory**. Information on a broad range of environmental, socioeconomic, and jurisdictional factors also needs to be collected. This information makes up the **biological and cultural inventories**.

Details about the types of information to be included in littoral cell inventories are outlined in the next four pages.

Phase I: Hazard Avoidance

Inventory

▼ Collect information on the physical, biological, and cultural characteristics of the littoral cell

Analysis

Stage 1: Risk Assessment

▼

Stage 2: Policy Development

Delineate 'risk zones' and specify avoidance policies and procedures within these zones

Implementation

▼ Adopt implementing language and follow-up with plan monitoring and maintenance

The Physical Inventory

Regional Setting. *Information such as the location and size of a given littoral cell or subcell, and its relationship to major geographic and geologic features which is needed to establish planning boundaries.*

- ***Major geographic features*** *including headlands, beaches, spits, dunes, bluffs, streams, inlets, offshore rocks/reefs, jetties, and any other natural or human feature that is characteristic of a given littoral cell or subcell. The identification of headlands, inlets, jetties and other features that interrupt littoral cell circulation and sedimentation are particularly important, since they represent the longshore boundaries of a given cell or subcell. The classification of shoreline morphologies is also important (i.e. dune-backed or bluff-backed shorelines) as they are indicate the extent processes of wave attack and/or mass wasting govern shoreline stability. The location, type, and condition of shore protection structures (e.g. rip rap revetments, seawalls) should also be inventoried.*

- ***Major geologic features*** *including rock types, their distribution, and stratigraphic and/or structural relationships. Typically this information takes the form of geologic maps, cross-sections and stratigraphic columns, which together describe the regional geologic setting and geologic history of a given segment of shoreline.*

Factors Affecting Chronic Shoreline Stability. *Information on the long term trend of shoreline change, episodic flooding and erosion events, and episodic sliding and slumping events is needed to establish the potential risk to development.*

- ***Long-term Trend of Shoreline Change.*** *Several different types of information can be collected and analyzed to determine the potential for long-term shoreline change.*

  - ***Historical dune/bluff retreat*** *is usually expressed as an estimate of the annual average recession rate. This estimate is typically obtained through an analysis of changes in shoreline, foredune, or bluff top position in consecutive sets of aerial photographs and/or ground surveys. Although annual average recession rates are often used as a primary indicator of long term shoreline stability, it is essential that limitations associated with these values be recognized. Sources of error attributable to photo quality, distortion related to tilt and pitch, and measurement and interpretation errors need to be quantified. Also, the time span of photo coverage is particularly important. Time spans on the order of 35 to 50 years are typically regarded as the minimum necessary to achieve reliable estimates of the annual average recession rate.*

  - ***Relative sea-level rise*** *is usually expressed as an estimate of the annual average change in shoreline position attributable to tectonic and eustatic changes in mean sea level. This estimate is commonly obtained through an analysis of geodetic surveys and tide gauge records. Along the Oregon coast, current rates of relative sea level rise are such that they are for the most part a minor concern. However, if rates of relative sea level increase as envisioned under scenarios of global warming in response to the greenhouse effect, then greater attention may need to be given to the potential effects of relative sea level rise.*

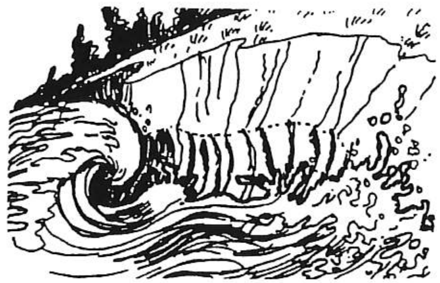
  - ***Sediment budget*** *including the identification of sediment sources (e.g. rivers, bluffs, dunes, and the inner shelf) and sinks*

The Physical Inventory *(continued)*

(e.g. bays, dunes, the offshore, dredging, and mining); estimates of the annual volumes of sediment gained from or lost to sources and sinks respectively; and estimates of gross and active sediment volumes within a given littoral cell or subcell.

• ***Short-term Shoreline Change Attributable to Episodic Flooding/Erosion Events.*** *Along dune-backed shorelines of the Oregon coast the primary consideration is often the extent to which a given segment of shoreline is subject to sudden changes associated with processes of wave attack during individual storms or clusters of storms. A variety of different types of information can be collected and analyzed to determine the potential for this type of short-term shoreline change.*

- ***Projected wave overtopping/undercutting*** *including information on beach processes and morphology such as: regional and local wind climate (e.g. wind speed, direction) with particular emphasis on extreme events and seasonal variability; regional and local wave climate (e.g. wave height, period, direction, duration); patterns of circulation (e.g. longshore currents, rip currents); mean water elevations due to tides and other sea-level components; beach/dune sediment characteristics (e.g. mean grain-size, sorting, composition); winter/summer beach/dune slope, width, elevation, and volume; elevation of the beach/dune or bluff intersection during summer and winter; and depth of beach sand down to bedrock at the seaward edge of the dune or bluff.*



This information can be used to estimate extreme runup elevations and the inland extent of shoreline erosion. There are a number of different geometric and numerical models that predict runup on beaches and modification of the beach profile during storms.[3,4] For example, the 100-year V-zone flood elevation projected by F.E.M.A is a model-derived estimate that has been applied along much of the Oregon coast. The Army Corps of Engineers SBEACH model has also been used to estimate runup/dune retreat along the Oregon coast.

- ***Direct evidence from existing and antecedent conditions*** *including information obtained from field reconnaissance and analysis of aerial photographs. The presence of rip current channels and the number and types of bars in the surf zone; the presence of scarps, berms, cusps or rip embayments, rap lines, drift logs, and rock outcrops in the foreshore and backshore; and dune type and orientation, and vegetation type and distribution in the foredune area can all be indicative of the susceptibility of a given segment of shoreline to wave attack.*

Examination of aerial photographs for these features, and for characteristic patterns of shoreline change (e.g. consistent seasonal and/or interannual patterns of erosion/accretion) can also provide valuable clues as to the possible nature of beach and dune responses to individual storms or clusters of storms. Documentation of human activities (e.g. site development, foredune grading, sand removal, shoreline stabilization, pedestrian/vehicular traffic, graffiti carving) should also be made.

The Physical Inventory (continued)

- ***Inlet dynamics*** *including information on patterns of inlet migration and the complex combination of wave, tidal, and fluvial forces that drive these changes. Inlet migration may be a primary consideration along some segments of dune-backed shoreline.*

- ***Dune stability*** *including information on the extent to which wind-driven sediment transport affects shoreline stability. Dune type and orientation, and vegetation type and distribution in the foredune area are indicative of the susceptibility of a given segment of shoreline to wind erosion and/or accretion.*

• ***Short-term Shoreline Change Attributable to Episodic Sliding/Slumping Events.*** *Along bluff-backed shorelines of the Oregon coast the primary consideration is often the extent to which a given segment of shoreline is subject to sudden changes associated with processes of mass wasting. Since they are commonly a factor contributing to slope instability, processes of wave attack also need to be considered. A variety of different types of information can be collected and analyzed to to determine the potential for this type of short-term shoreline change.*

- ***Surface features*** *including information on geomorphic features typically associated with landslide topography (e.g. steep slopes, hummocky topography, slide scarps, sag ponds, tilted trees, aligned springs, disrupted drainage, and vegetation patterns). This type of information is readily obtained through field reconnaissance or analysis of aerial photographs. If possible, the type of slide (e.g. prehistoric rock/soil flow, potentially active complex landslide, active complex slide/slump block,) its limits, and its rate and recurrence of movement should be identified. Documentation of human activities (e.g. site development, foredune grading, sand removal, shoreline stabilization, pedestrian/vehicular traffic, graffiti carving, etc.) should also be made.*

- ***Material properties and structural characteristics*** *including information such as composition, grain size, cementation, strength, or other special engineering geologic characteristics. It also includes information such as thickness of stratification, orientation of bedding, faults, zones of weathering, and any other special structural features or relationships, both at the surface and in the subsurface. Drilling, trenching, and geophysical surveys are some of the techniques that are commonly used to obtain this type of information. Formal slope stability analysis might also be warranted.*

- ***Surface/subsurface drainage*** *including information such as precipitation amounts, the location of drainage courses, ponds, swamps, springs, seeps, aquifers. With respect to the identification and characterization of aquifers, consideration should be given to the depth to ground water and its seasonal fluctuations, flow direction, gradient, recharge and discharge areas, and its relationships to geologic or biologic features (e.g. mineral deposits, vegetation).*

• ***Wave attack*** *including the types of information described above as needed to determine the potential for short term shoreline change attributable to episodic flooding/erosion events, and with a particular emphasis on establishing the buffering capability of the fronting beach. Qualitative indicators, such as the presence or absence of talus at the toe of slopes and the extent and age of vegetation cover should also be looked for.*

Biological and Cultural Inventories

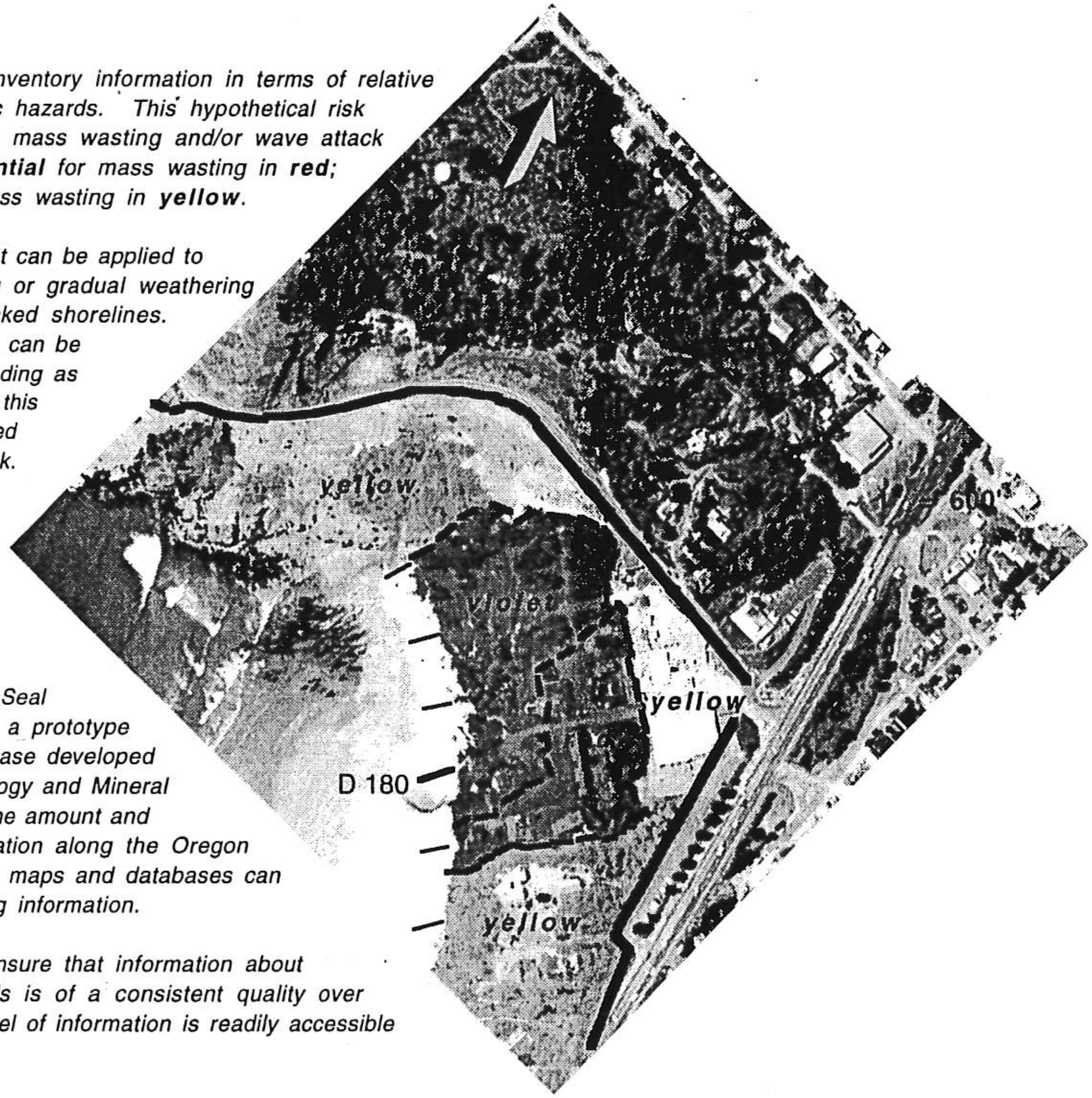
Types of information that need to be collected and analyzed comprise a broad range of environmental, socioeconomic, and jurisdictional factors.[5,21,22,32,35, 36]

• **Environmental factors** including information on major marshes, significant wildlife habitat, exceptional aesthetic resources, or other natural resources that may occur within a given littoral cell or subcell. Areas with threatened or endangered species (e.g. snowy plover, silverspot butterfly, pink sand verbena). Outstanding views, historical, scientific, educational, or other cultural resources can also be considered under this category.

• **Socioeconomic factors** including information on the types and levels of use and the associated activities that may occur within a given littoral cell or subcell. Types and levels of use can be categorized as:
-**Recreational**, be it water-dependent or non water-dependent;
-**Residential**, be it low density or high density;
-**Commercial;**
-**Industrial;** and
-**Critical facilities and infrastructure** (e.g. hospitals, schools, highways, water and power lines).
Housing, transportation, public facilities, and other factors connected to economic development can also be considered under this category.

• **Jurisdictional factors** including information on the patterns of public and private ownership of portions of the shoreline in a given littoral cell or subcell and the agencies which have authority over shoreline uses and activities. This includes:
-**Private property owners;**
-**Local government**, both city and county governments, as well as port districts or other special districts;
-**State government**, regulatory and resources agencies including the Oregon Parks and Recreation Department (OPRD), the Oregon Division of State Lands (ODSL), the Oregon Department of Land Conservation and Development (DLCD), the Oregon Department of Fish and Wildlife (ODFW), and the Oregon Department of Environmental Quality (DEQ); and
-**Federal government**, regulatory and resource agencies including the Army Corps of Engineers (ACOE), the Federal Emergency Management Agency (FEMA), the Bureau of Land Management (BLM), the Environmental Protection Agency (EPA), and the United States Fish and Wildlife Service (USFW).
Clearly, the extent to which these various owners and agencies will be involved in littoral cell management planning will vary from cell to cell

Risk Zone Maps



*Risk zone maps depict physical inventory information in terms of relative risks to development from chronic hazards. This hypothetical risk zone map shows areas of **Active** mass wasting and/or wave attack in **violet**; areas with **High Potential** for mass wasting in **red**; and **Moderate Potential** for mass wasting in **yellow**.*

Mass wasting is a general term that can be applied to processes of landsliding, slumping or gradual weathering that are prevalent along bluff-backed shorelines. Wave attack is a general term that can be applied to processes of ocean flooding as well as beach and dune erosion. In this document dune accretion is included under the category of wave attack. These processes are prevalent along dune-backed as well as bluff-backed shorelines.

In this image the symbol D180 indicates the location of one in a series of reference transects established from Cascade Head to Seal Rock in Lincoln County as part of a prototype all chronic hazards map and database developed by the Oregon Department of Geology and Mineral Industries (DOGAMI)[7]. Although the amount and quality varies from location to location along the Oregon coast, in many instances risk zone maps and databases can be developed using mostly existing information.

Risk zone maps and databases ensure that information about potential risk from chronic hazards is of a consistent quality over a wide area and that the same level of information is readily accessible to decision-makers at all levels.

Phase I: Hazard Avoidance (continued)

Analysis - Stage 1: Risk Assessment Once inventory information has been collected, it needs to be analyzed to assess the potential risks attributable to the individual and cumulative effects of chronic hazards present within any given littoral cell or subcell. This stage in the planning process is referred to as **risk assessment.** Risk assessment is a fundamental component of the littoral cell management planning process. It provides information needed to make decisions at other steps in the planning process.

A framework for conducting a risk assessment is outlined in the side bar on this page and over the next three pages. It identifies risk zone parameters and applies a methodology using these parameters to assign different levels of risk to different areas within a given littoral cell. For example, segments of littoral cell or subcell shoreline can be classified as:

- **Active** - areas currently subject to or likely subject to wave attack or mass wasting within the next ~10 years;
- **High Potential** for activity - areas likely subject to wave attack or mass wasting within the next ~10 to 50 years; or
- **Moderate Potential** for activity - areas likely subject to wave attack or mass wasting within the next ~50 to 100 years.

This classification scheme, which expresses levels of risk in terms of the relative potential for activity, is used throughout the remainder of the discussion. However, one can readily imagine others that may also be appropriate means of categorizing the level of risk.

Risk zone maps and databases are one way in which information of this type can be synthesized into a readily accessible format.

Risk Zone Parameters

'RISK' from chronic hazards present within a given littoral cell can be described in terms of

$(T)\ (R)\ (S_{dune})\ (S_{bluff})\ (H)\ (f)$

*T = **anticipated years of avoidance or protection;***

*R = **long term trend of shoreline change,** which includes the historical rate of retreat along bluff-backed shorelines. and r = relative sea level rise, the effects of which may be relevant along some segments of dune-backed shoreline;*

*S_{dune} = **short term shoreline change attributable to episodic flooding/erosion events,** which includes the effects of water and wind-driven sediment transport typical of dune-backed shorelines;*

*S_{bluff} = **short term shoreline change attributable to episodic sliding/slumping events,** which includes the effects of gravity-driven sediment transport typical of bluff-backed shorelines;*

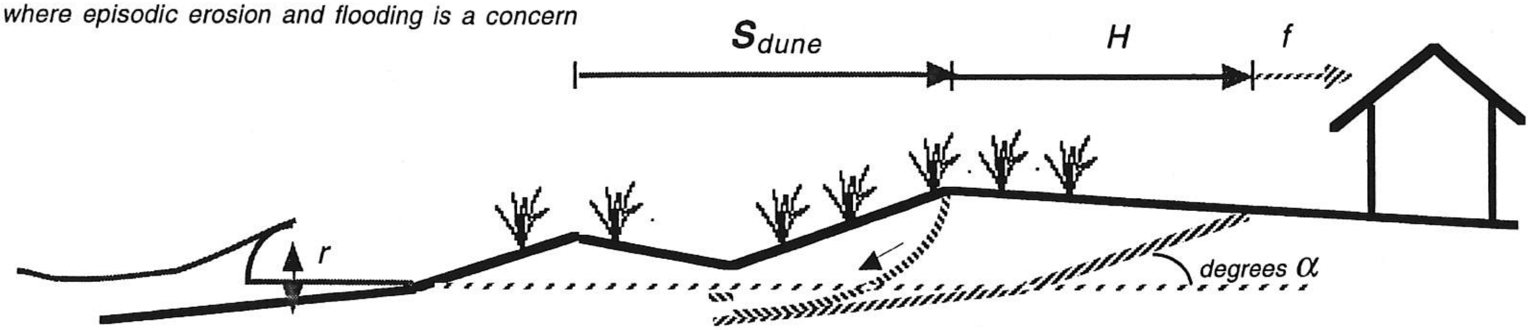
*H = **angle of repose typical of a given shoreline morphology;** and*

*f = **a safety factor,** which accounts for uncertainties related to information quality.*

Risk Zone Delineation

Dune-backed shorelines

where episodic erosion and flooding is a concern

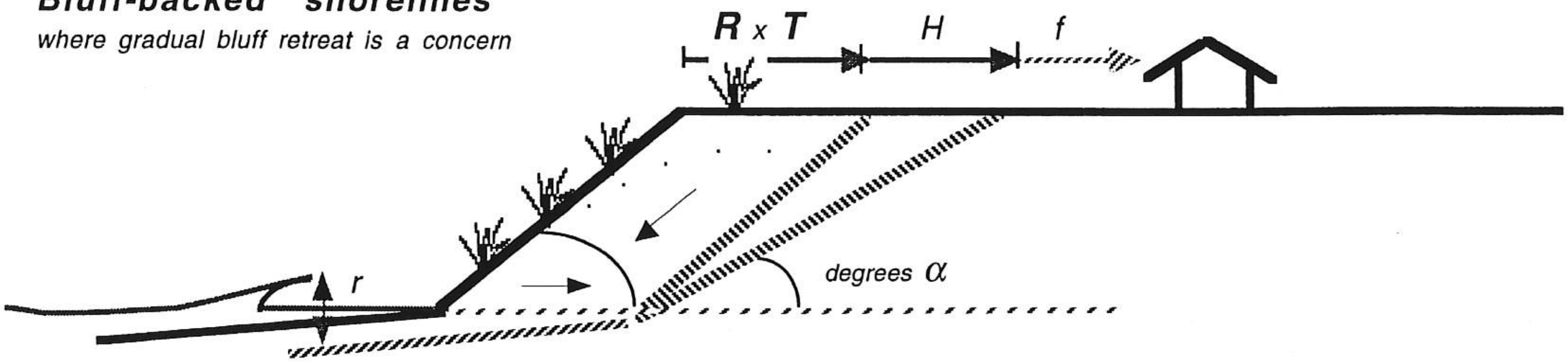


Along dune-backed shorelines where episodic erosion and flooding is a concern, S_{dune}, H, and f are the relevant terms, where S_{dune} is the amount of short-term shoreline change attributable to episodic erosion/flooding events, H is the angle of repose, and f is a safety factor. Actual numerical values of S_{dune} are measured in feet from the the location of the accreted foredune crest or erosion scarp. Typically, H can be taken as an angle of 22 to 27 degrees from the beach-dune junction. This corresponds to a distance to be added to S_{dune}, and represents the shoreward translation of an accreted foredune morphology. In this instance the safety factor, f, might be accounted for by taking an S_{dune} value that is the mean plus one standard deviation from the mean rather than the mean S_{dune} value.

Risk Zone Delineation

Bluff-backed shorelines

where gradual bluff retreat is a concern

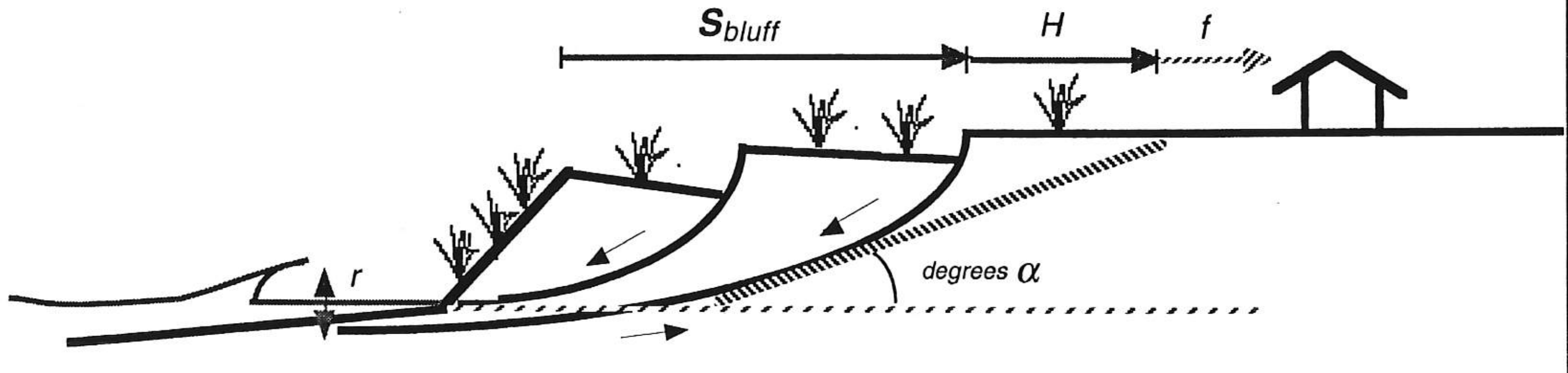


Along bluff-backed shorelines where gradual bluff retreat is a concern, R, T, H, and f are the relevant terms, where R is the projected annual average recession rate and T is the anticipated years of avodiance or protection (e.g. 10, 50, and 100 year time spans). R and T are multiplied to determine a distance in feet from the top of the bluff. The angle of repose, H, may vary from 27 to 45 degrees from the beach-bluff junction, depending on bluff composition, structure, geometry, etc. This will correspond to a distance to be added to R x T, and is intended to account for the fact that the basic distance described above does not account for the existence of an over steepened bluff profile. The safety factor, f, might be accounted for by taking an R value that is the mean plus one standard deviation from the mean rather than the mean R value.

Risk Zone Delineation

Bluff-backed shorelines

where where landsliding/slumping is a concern



Along bluff-backed shorelines where landsliding/slumping is a concern, S_{bluff}, H, and f are the relevant terms. S_{bluff} is the amount of short-term shoreline change attributable to episodic sliding/slumping events. Actual numerical values of S_{bluff} are measured in feet from the top of the bluff landward to the location of the head scarp. The angle of repose, H, may vary from 27 to 45 degrees from the beach-bluff junction, depending on bluff composition, structure, geometry, etc. This corresponds to a distance to be added to S_{bluff}, and represents the shoreward translation of a stable bluff slope morphology. A safety factor, f, may also be warranted.

Phase I: Hazard Avoidance (continued)

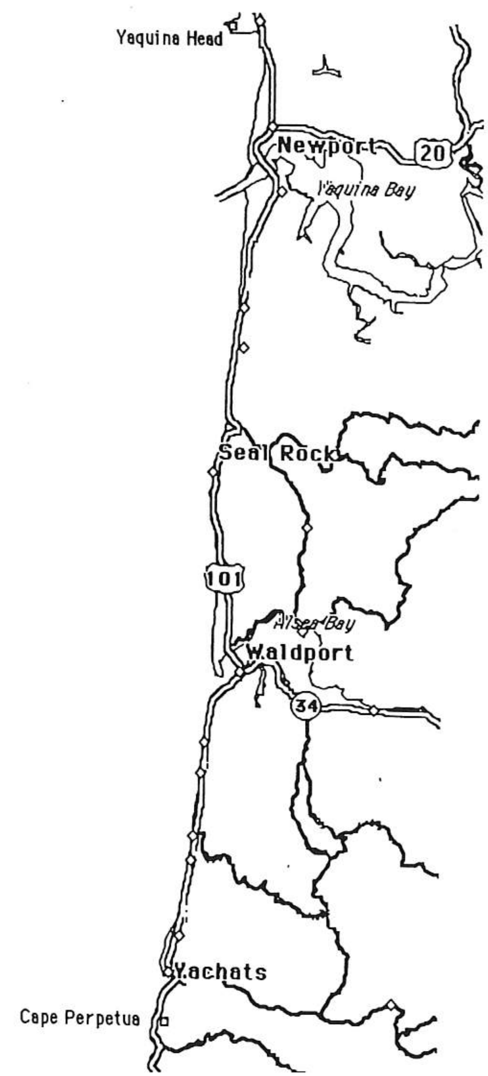
Analysis - Stage 2: Policy Development. The next step in the planning process is to examine the results of the risk assessment in conjunction with biological and cultural inventory information in order to formulate hazard avoidance policies appropriate to different segments of littoral cell shoreline and establish procedures to implement these policies. There are a variety of hazard avoidance options that can be considered during this **policy development** stage of the littoral cell management planning process. One of these options is construction setbacks for various types and levels of new oceanfront development. For example, it might be determined that:

- **Low density 'rural' residential development** (e.g. single and multi-family dwellings or other structures less than 5000 square feet and/or those which are readily movable) is appropriate in areas with Moderate Potential for activity and may be appropriate in areas with High Potential for activity;

- **High density 'urban' residential development** (e.g. residential dwellings greater than 5000 square feet) as well as **commercial and/or industrial development** (e.g. hotels, motels, restaurants, factories, etc.) is generally inappropriate in areas with High Potential for activity but may be appropriate in areas with Moderate Potential for activity; and

- all new habitable structures are generally inappropriate in Active areas.

Similar types of standards can also be applied to critical facilities and infrastructure, and even to the repair or remodeling of existing structures. Clearly, provisions will need to be made for unique situations where, for example, a lot is found to lack sufficient depth to meet the established



The Newport Littoral Cell

Hazard Avoidance Use/Activity Matrices

Use/activity matrices are the sort of product that will result from the policy development stage of the planning process. The examples given below show how hazard avoidance policies can vary with the level of existing development. The use/activity matrix applicable along moderately developed shorelines corresponds to the construction setback standards described in the text of this document. In contrast, the use/activity matrices for lightly and heavily developed shorelines are more and less restrictive respectively.

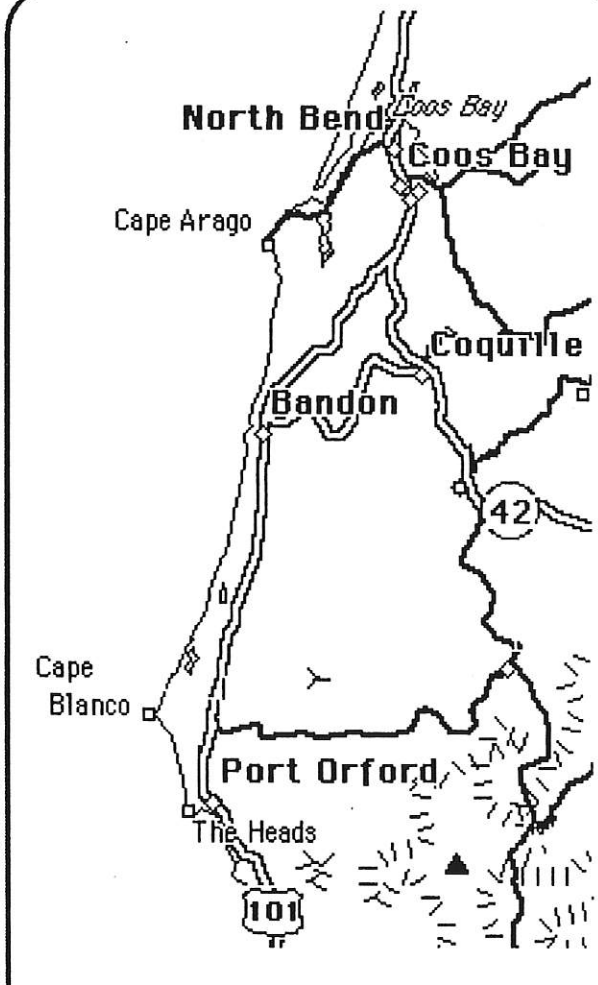
Risk Potential

New Development	Active	High	Moderate	Active	High	Moderate	Active	High	Moderate
• Low-Density Residential	○	○	⊘	○	⊘	●	⊘	●	●
• High-Density Residential	○	○	○	○	○	⊘	○	⊘	●
• Commercial/Industrial	○	○	○	○	○	⊘	○	⊘	●
• Critical Facilities and Infrastructure	○	⊘	⊘	○	⊘	●	⊘	●	●
along	**'Lightly' Developed** or undeveloped areas, and areas with low intensity uses such as recreational or low density residential use in predominantly rural settings			**'Moderately' Developed** areas or areas with moderate intensity uses, and areas directly adjacent to areas with high levels of development or high intensities of use			**'Heavily' Developed** areas and areas with high intensity uses such as high density residential or commercial/industrial use in predominantly urban settings		

● is Appropriate ⊘ May be Appropriate ○ is Generally Inappropriate

Phase I: Hazard Avoidance (continued)

standard. In this regard, hazard avoidance options such as relocation or land acquisition might be considered. Other hazard avoidance options to consider include zoning controls and infrastructure planning. Providing for clustering, or perhaps even down-zoning and limiting the level of future services can be an appropriate means of reducing risks to new development in hazardous areas. Similarly, existing siting, design, and construction standards can be reviewed and updated.



The Bandon Littoral Cell

Implementation. It is at this point in the planning process that the materials which constitute the littoral cell management plan are adopted. This may be done either formally or informally at local, state, and federal levels of government. A process of plan monitoring and maintenance also need to be implemented. There are a number of different types of administrative actions or agreements that can be taken to ensure that the policies and procedures which constitute a hazard avoidance strategy are applied consistently across intergovernmental and interagency boundaries.

- **Local governments** will formally adopt relevant portions of the littoral cell management plan into their comprehensive plans and zoning ordinances. This includes maps and databases, as well as avoidance policies and procedures. Also they will enter into coordination agreements with other jurisdictions, port districts, or other special districts as needed.

- **State and Federal agencies** will implement relevant portions of the littoral cell management plan, first by being subject to consistency with local comprehensive plans, and second through policy letters or preferably through memoranda of understanding.

Special Area Management Planning

Like littoral cell management plans, special area management plans are a comprehensive set of integrated policies and criteria guiding public and private uses of lands and waters within a limited geographic area.[12] *Such integrated, regional, advanced plans reduce conflicts between government agencies, development interests, and environmental groups. This, in turn, increases predictability in a way that enhances resource protection, economic development, and other interests.*

As the benefits of special area management planning have become well recognized over the last twenty years, a variety of plans have been developed throughout the world. In the United States some of the earliest and best examples can be found in the Pacific Northwest. Oregon's estuary plans are a good example. Wetland conservation plans, rocky shores management plans, waterfront revitalization plans, and foredune management plans, are more recent examples of the application of special area management planning concepts along the Oregon coast. [9,12,13,21,22,25,26,30,31,32,34,35,36]

Special area management planning is often applied in situations where the need to resolve conflicts between multiple interests is well recognized. It typically involves a more elaborate 'facilitated collaborative' decision-making process than what is envisioned for littoral cell management planning. As a result, special area management planning is likely to require greater financial resources and longer time frames than those needed for littoral cell management planning.

Special area management planning commonly employs 'regional balancing' as a means of reconciling conflicting objectives. This involves the identification of individual management units within the overall management area. For each management unit, different management objectives and/or different priorities in terms of management objectives are established. As a result, different types of uses and activities are allowed within each management unit. For example, in a management unit where the maintenance of natural resources values has been established as a priority, then allowed uses may be limited principally to recreational or other low intensity types of use: In a management unit where the maintenance of economic opportunities has been established as a priority, then commercial or other types of high intensity use may be allowed.

Communities wanting to address a broader range of objectives, and correspondingly a more comprehensive list of shoreline uses and activities than those included in chronic hazards management strategies, should consider this approach.

Phase I: Hazard Avoidance (continued)

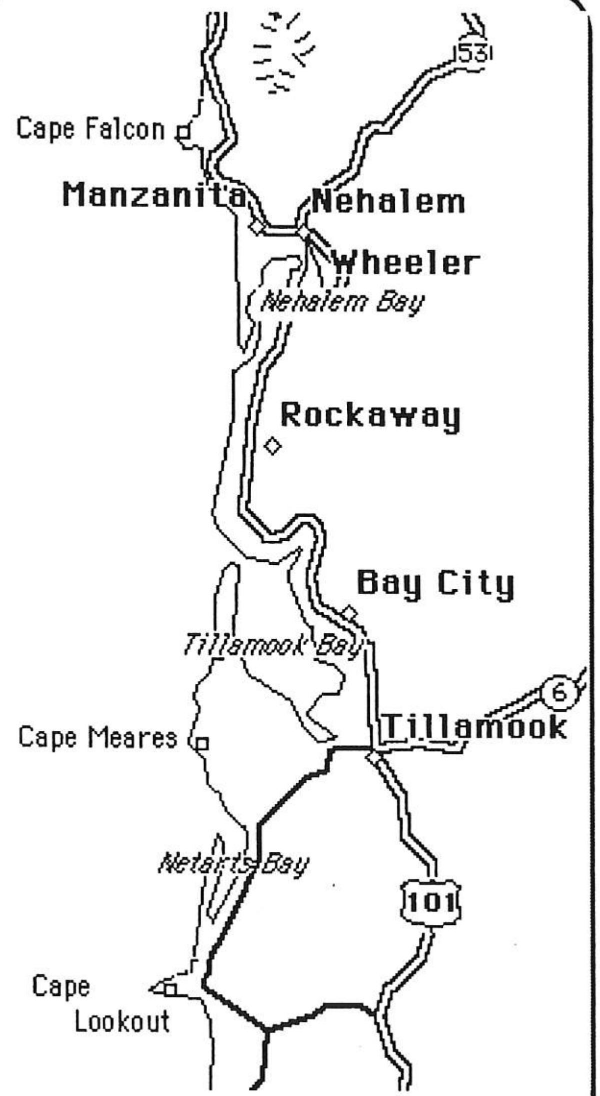
It is intended that littoral cell management plans be adopted voluntarily and implemented within the existing regulatory and land use planning programs. It is unlikely that new or revised statutes, goals, or rules will be needed. This suggestion is consistent with the purpose of littoral cell management planning - to simplify and coordinate the existing management system, not create a new one.

Following adoption, attention will focus on the implementation of monitoring and maintenance elements of the littoral cell management plan. Like the implementation mechanisms described above, such measures will have been identified during the policy development stage of the planning process. Monitoring and maintenance includes:

- **Day-to-day actions** involving specific applications such as building permits and beach improvement permits. For example, a process for coordinating the review of applications needs to be established. Conducting preapplication meetings where affected interest groups are able to review proposals prior to formal submittal is a likely first step in such a coordinated review process.

- **Annual review** of decisions and of the cumulative effect of decisions carried out under the plan. Gathering those individuals involved in implementing the plan together on a regular basis not only provides a means to make minor adjustments, but also helps to maintain continuity.

- **Five-year evaluation** of the plan's success relative to the objectives identified during the policy development stage of the planning process. Attention also needs be given to any substantial change in circumstances that might have occurred since initial plan adoption. The plan should be amended to address these concerns. Additionally, the inventory information that forms the basis of the littoral cell management plan should be reviewed and updated at this time.

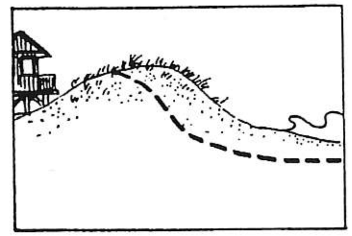


The Rockaway and Netarts Cells

Beach and Shore Protection Options

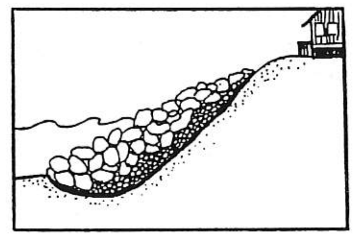
Beach and shore protection options are techniques which can be used to reduce potential risk by acting to retard or prevent the effects of wave attack and/or mass wasting.[5] Such options are typically used for existing development. Examples of beach and shore protection options include:

'Soft' Options for Processes of Wave Attack. *'Soft' options are techniques which reduce potential risk by enhancing the inherent buffering capabilities of the natural shoreline system. Although the shoreline is stabilized in a relative sense through the application of these techniques, it is still expected to experience displacements during storm events. Soft options include:*



- *Dune and Bluff Enhancement*
- *Beach Nourishment*
- *Boulder berms (also called 'dynamic revetments')*

'Hard' Options for Processes of Wave Attack. *'Hard' options are techniques which reduce potential risk by attempting to fix the position of the shoreline. Because the shoreline is stabilized in a real sense through the application of these techniques, it does not experience displacements during storm events. Hard options include:*



- *Revetments and Seawalls*
- *Breakwaters*
- *Groins*

Options for Processes of Mass Wasting. *The following techniques are typically used in combination to increase slope stability:*

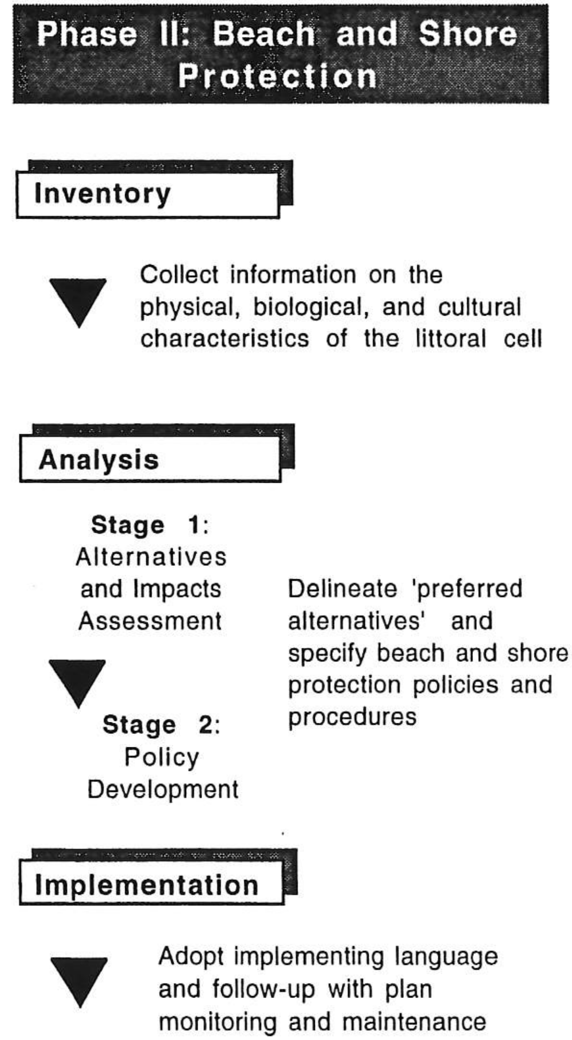
- *Vegetation Management*
- *Drainage Controls*
- *Slope Regrading*
- *Reinforcing Structures*
- *Surface Fixing*

Phase II: Beach and Shore Protection

Inventory. Much of the inventory information collected during the first phase of the littoral cell management planning process can be used to develop beach and shore protection strategies. However, additional inventory information may need to be collected. In particular, littoral cell sediment budgets may be required to more accurately assess hazard alleviation needs and to better understand the positive and negative impacts of potentially applicable beach and shore protection options. Also, as interests other than hazard alleviation are likely to play a more prominent role in this phase of the planning process, additional biological and cultural inventory information may need to be collected.

Analysis - Stage 1: Alternatives and Impacts Assessment. At this stage in the planning process inventory information needs to be analyzed to identify potential beach and shore protection techniques. Then all positive and negative impacts associated with these techniques need to be specified. This will lead to the identification of preferred alternatives. Because hazard alleviation needs vary both within and between littoral cells, it is likely that a combination of beach and shore protection techniques will need to be employed. Community perspectives will undoubtedly influence the decision as to what combination of options is appropriate in any given littoral cell or subcell.

Beach and shore protection techniques can be compared through a cost-benefit analysis. However, in most instances an elaborate cost-benefit analysis will not be necessary. Simply structuring the **alternatives and impacts assessment** in a cost-benefit context can be sufficient to reveal preferred alternatives. To illustrate these concepts, the results of a hypothetical alternatives and impacts assessment are given in the side bar on the following page. There are certainly other methodologies that can be



Example of an **Alternatives and Impacts Assessment** for a dune-backed shoreline

Hazard Alleviation Techniques \ **'Impacts'**	**DESIGN** level/life	technical certainty	adverse impacts	**COSTS** short term	long term	**SOCIAL** factors	**ENVIRONMENTAL** factors	level of **REGULATION**	
• Foredune Enhancement	2	4	4	4	4	4	4	4	**30** (preferred alternative)
• Boulder Berm	3	1	4	2	2	3	3	3	21
• Rip Rap Revetment	5	5	2	2	4	2	2	2	24

This hypothetical alternatives and impacts analysis compares positive and negative attributes of three hazard alleviation options potentially applicable along dune-backed shorelines. A series of evaluation criteria are identified along the top of the diagram. Each alternative - foredune enhancement, boulder berm, and rip rap revetment - is scored in terms of these criteria. In this case, scores range from 1 to 5, with lower scores representing relatively negative impacts and higher scores relatively positive impacts. By totaling the set of scores for each alternative, a 'preferred alternative' can be identified.

The use of evaluation schemes such as this is commonplace. However, it is essential to keep the value judgments and tradeoffs inherent in such a methodology in mind. Although they may at first glance appear fairly straight forward, upon closer inspection this is rarely the case. It is important, therefore, to incorporate a broad range of stake-holder perspectives into such an analysis.

Phase II: Beach and Shore Protection (continued)

used to identify preferred beach and shore protection techniques for a given littoral cell or subcell.

Analysis - Stage 2: Policy Development. As was the case with the hazard avoidance strategy, the results of the alternatives and impacts assessment need to be examined in order to formulate beach and shore protection policies appropriate to different segments of littoral cell shoreline and establish procedures to implement these policies. For example, during this **policy development** stage of the littoral cell management planning process it might be determined that:

- **Dune and Bluff Enhancement** (e.g. foredune or bluff grading, vegetative stabilization, drainage controls) is appropriate in Active areas and in areas with High Potential for activity, and may be appropriate in areas with Moderate Potential for activity; and

- **Revetments and seawalls** may be appropriate only in Active areas, and then only where it has been shown that non-structural solutions have failed to provide adequate hazard alleviation and only when constructed according to prescribed design standards. This is in effect an 'imminent threat' criterion.

These are two simple examples of standards that might be incorporated into a beach and shore protection strategy. More elaborate strategies involving active management of the sediment budget may be feasible in some Oregon coast littoral cells. Policies and procedures that allow sand to be transferred from accreted to depleted areas can be put in place. For example, in some littoral cells shallow-water disposal of material dredged from navigation channels could be allowed. In others, sand that has accumulated at the northern end of the cell may be backpassed to the

POSITIVE versus NEGATIVE IMPACTS

Economic, social, and environmental factors that may affect the feasibility of a given beach and shore protection option, and which can be expressed in terms of positive (benefits) and negative (costs) impacts include[5, 29, 33]:

- *The **design level/life**, by determining the duration of protection, establishes the value directly associated with the extension of use of protected structures or infrastructure. The value indirectly associated with the extension of use (e.g. tourism dollars associated with maintenance of a wide, sand beach) should also be considered in this regard.*

- *The real monetary expense involved in development and implementation of a given option including **short term costs** associated with concept formulation and construction as well as **long term costs** associated with maintenance and monitoring. The **level of regulation** is a factor that can also be considered in this category.*

- ***Adverse impacts** to the adjacent shoreline **and cumulative effects** on the littoral cell shoreline including increased shoreline erosion and the degradation of views under **social consequences**, and the loss of habitat under **environmental consequences**.*

Beach and Shore Protection Use/Activity Matrices

Use/activity matrices are the sort of product that will result from the policy development stage of the planning process. The examples given below show how beach and shore protection policies can vary with the level of existing development. The use/activity matrix applicable along moderately developed shorelines corresponds to the standards described in the text of this document. In contrast, the use/activity matrices for lightly and heavily developed shorelines are more and less restrictive respectively. Specifically, along lightly developed shorelines 'soft' options are preferred to the exclusion of 'hard' options. Along heavily developed shorelines both 'soft' and 'hard' options are acceptable.

Risk Potential

Hazard Alleviation Technique	'Lightly' Developed: Active	High	Moderate	'Moderately' Developed: Active	High	Moderate	'Heavily' Developed: Active	High	Moderate
• Dune/Bluff Enhancement	●	⊘	○	●	●	⊘	●	●	⊘
• Beach Nourishment	●	⊘	○	●	●	⊘	●	●	⊘
• Boulder Berms	⊘	○	○	⊘	○	○	●	⊘	○
• Revetments/Seawalls	○	○	○	⊘	○	○	●	⊘	○

along

'Lightly' Developed *or undeveloped areas, and areas with low intensity uses such as recreational or low density residential use in predominantly rural settings*

'Moderately' Developed *areas or areas with moderate intensity uses, and areas directly adjacent to areas with high levels of development or high intensities of use*

'Heavily' Developed *areas and areas with high intensity uses such as high density residential or commercial/industrial use in predominantly urban settings*

● ***is Appropriate*** ⊘ ***May be Appropriate*** ○ ***is Generally Inappropriate***

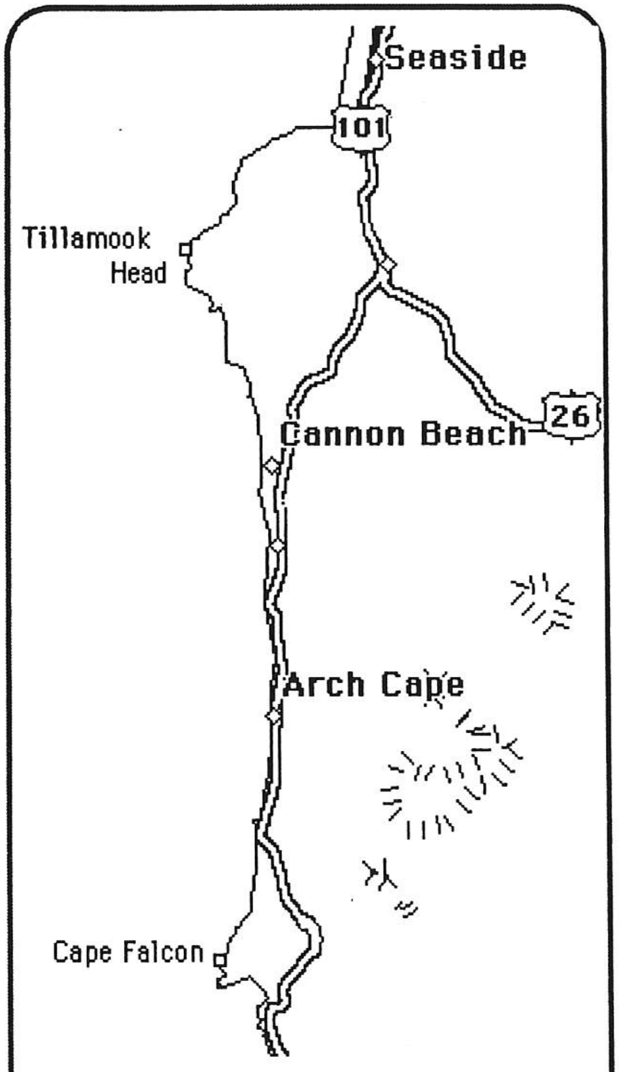
Phase II: Beach and Shore Protection (continued)

southern end of cell. These management measures have the advantage of providing hazard alleviation not only to segments of shoreline where flooding/erosion potential is greatest, but also to segments of shoreline where sand accumulation is itself a potential hazard. Also, they recognize the value of maintaining a wide sandy beach - from the perspective of hazard alleviation, as well as from economic, social, and environmental perspectives.

Under such sand management scenarios, structural stabilization may be allowed on a lot by lot basis, provided it is built in accordance with design standards applicable along the entire segment of shoreline and anticipated losses to the sediment budget are compensated. In some instances, such as along lightly developed dune-backed shorelines, beach and shore protection strategies may prohibit structural stabilization entirely, and instead prescribe appropriate foredune management measures. In other instances, such as along heavily developed or significantly altered shorelines, protection strategies may simply prescribe design standards for shore protection structures. Possible beach and shore protection strategies are limited only by one's imagination.

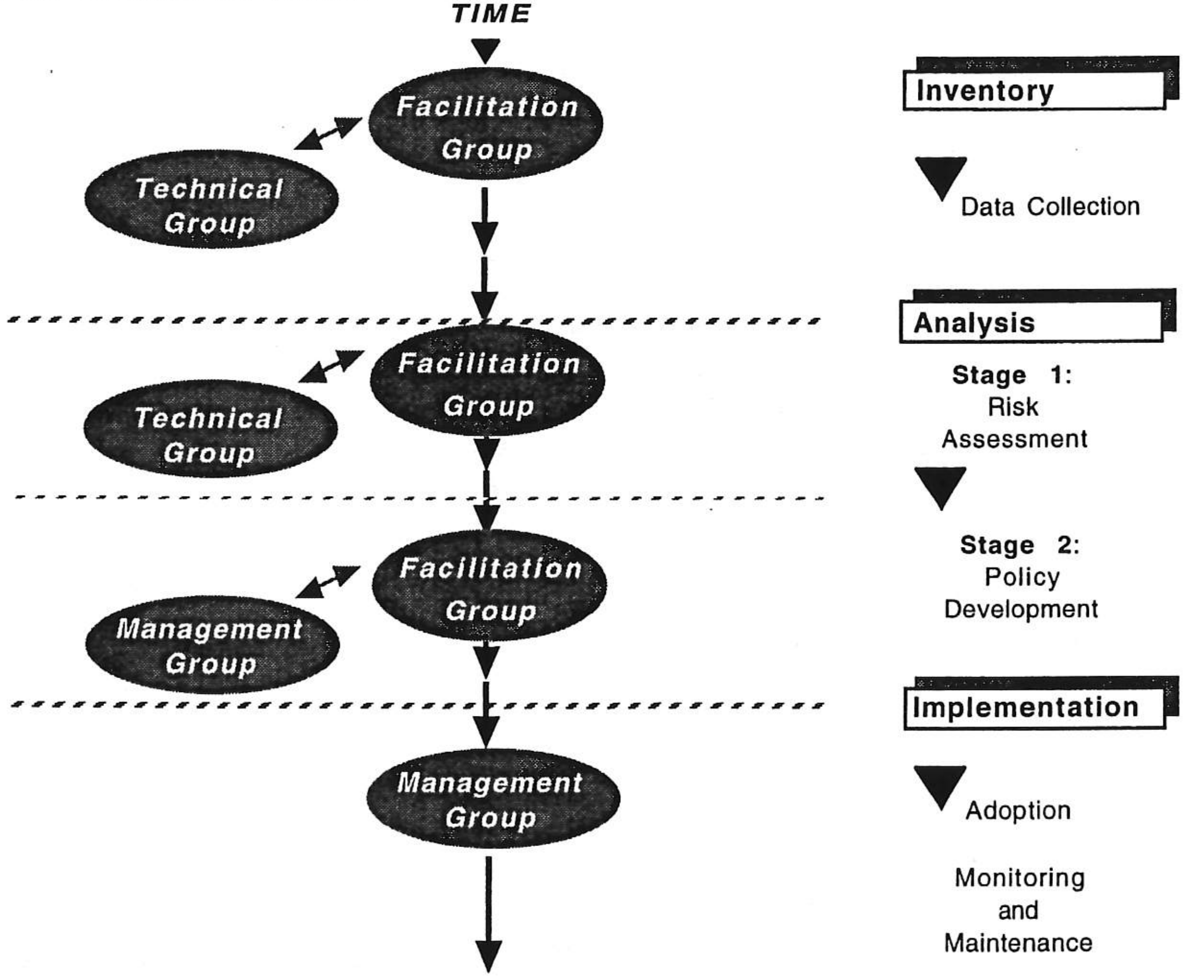
Implementation. Materials which constitute the littoral cell management plan -in this instance the beach and shore protection strategies- need to be adopted either formally or informally at local, state, and federal levels of government. Following adoption, attention will shift to the implementation of monitoring and maintenance elements of the plan. Specialized monitoring and maintenance programs may need to be applied to specific techniques such as beach nourishment or rip rap revetments.

For more detail on plan implementation see the same section under Phase I.



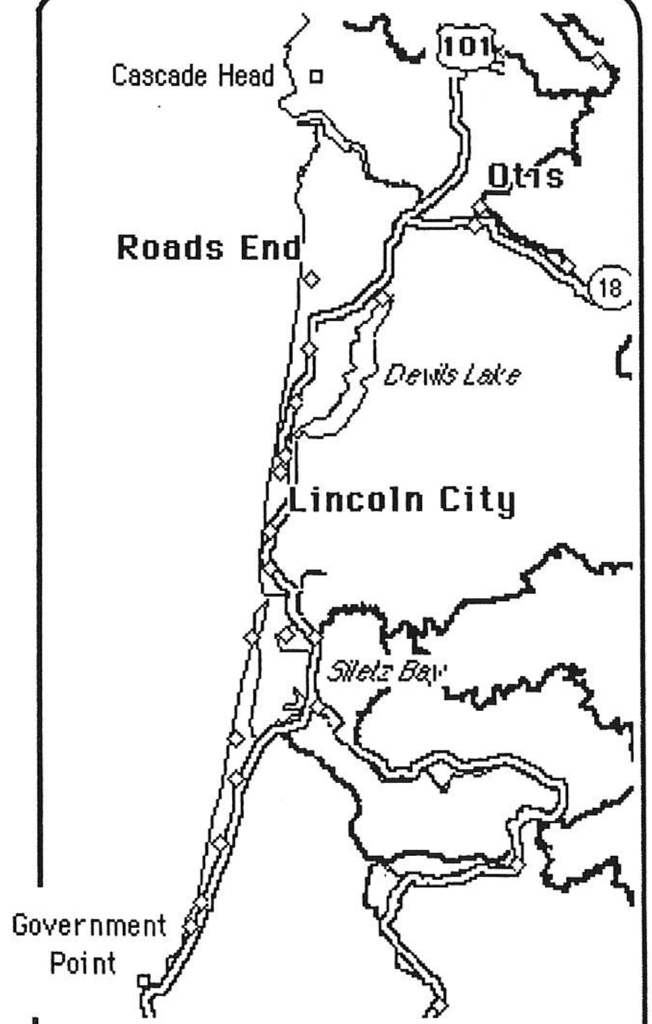
The Cannon Beach Littoral Cell

Participants at various stages of the Littoral Cell Management Planning Process. *The right hand side of this diagram shows the stages of Phase I of the planning process. The left hand side shows the different groups involved at different stages of the process. Basically, the facilitation group oversees the planning process, inventory and analysis are conducted by the technical group, and plan policies and procedures are formulated by the management group. The double-ended arrows indicate group interaction. The vertical line with arrows is a time line, with the arrows indicating benchmarks such as meetings and/or completed products.* ***See the text on the accompanying page for further detail on the groups' composition and functions.***



Who develops and implements a littoral cell management plan?

Up to this point, this document has focused on describing the activities and products associated with the various stages of the littoral cell management planning process. Participants and their roles in the process also need to be identified. Because a broad range of expertise and perspectives is needed to develop and implement a littoral cell management plan, a variety of individuals will generally need to be assembled. Separate facilitation, technical, and management groups can be identified. The composition and function of these groups is described below. However, exactly who participates and in what manner will vary with community needs and resources.



The Lincoln City Littoral Cell

• **The facilitation group** will play the lead role in guiding a community through the littoral cell management planning process. It defines the scope and sets the agenda, establishes the boundaries of the planning area, and selects the members of the technical and management groups. Other functions to be performed by this group will include: compiling and disseminating information to participants; acting as a liaison between different groups in the planning process; and facilitating negotiations within and between these groups. The facilitation group should be established as a formal entity that convenes on a regular basis until the littoral cell management plan is implemented.

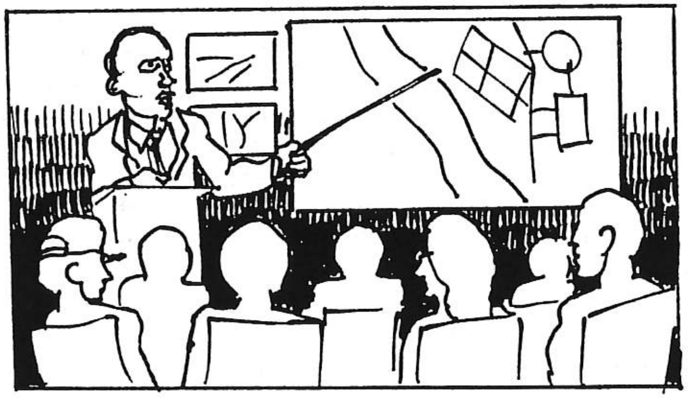
Because littoral cell management planning is intended to be a community-based effort, the facilitation group should be composed of city and county planners, or other local officials who initiated the process, can oversee it, and can be completely involved in it. State regulatory and resource agency personnel should also be members of this core group, since they can provide the technical and financial support needed to develop and implement a littoral cell management plan.

Although not a necessity, some communities may choose to employ a consultant to lead them through the planning process or to provide assistance at specific stages in the process. Whether to use a consultant

Citizen Involvement

For littoral cell management planning to be successful it is essential that there be broad-based community support. This means that local political leaders and citizens alike must be informed and involved, both early and often. Some of the ways in which the entire community can be educated about the littoral cell management planning process and encouraged to participate in it include: [1, 35]

- *Making early contact with key elected officials, community leaders, and other stakeholders to inform them about the purpose and expected outcomes of the planning process;*



- *Soliciting stakeholder opinions through community-wide surveys, interviews, or workshops;*

- *Holding regularly scheduled, well advertised open meetings;*

- *Making regular progress reports to governing bodies and presentations to citizens groups; and*

- *Developing brochures, newsletters, or other types of informational materials that describe the social, economic, and environmental benefits that can be achieved through littoral cell management planning.*

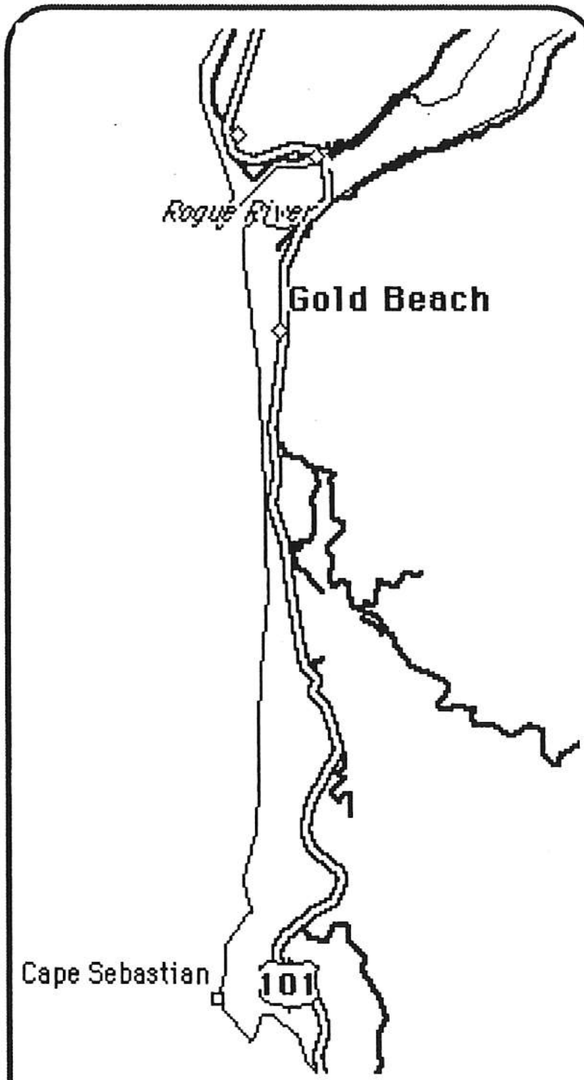
and selecting a consultant will be the first decisions the facilitation group makes.

• **The technical group** can be composed of geologists, geographers, oceanographers, engineers, vegetation specialists, planners, economists, lawyers, and other individuals with specialized knowledge, skills, or experience. Although the technical group may be formally established, it is probably best viewed as a fluid entity that meets on an as needed basis.

The technical group will play a lead role during the inventory stages of the littoral cell management planning process. Its members will be responsible for data collection and analysis needed to develop the littoral cell inventories. This group will also have a key role during the risk assessment and alternatives and impacts assessment stages of the planning process. It will be responsible for conducting much of these analyses. Input from various members of this group may also be needed during policy development stages of the planning process.

• **The management group** should be composed of representatives of: city and county government, port districts or other special districts; landowners and developers, citizens and representatives of environmental groups, or other potential stake-holders; and federal and state regulatory and resource agencies. The management group should be established as a formal entity that convenes on a regular basis.

The management group plays a limited role during the inventory stages of the planning process. Its role is more prominent during later stages. Because its members will include those individuals responsible for regulatory and and resource management decisions, it will play a lead role during the policy development stages of the planning process. It will formulate the specific policies and procedures which taken together constitute a chronic hazards management strategy. Also, it will play a key role in plan implementation. Its members will assist in accomplishing plan adoption. Finally, it is members of the management group that will be responsible for conducting post-adoption plan monitoring and maintenance.



The Gold Beach Littoral Cell

Notes...

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Acknowledgments

On behalf of the Oregon Coastal Zone Management Association (OCZMA), Shoreland Solutions wishes to thank all those who participated in the advisory group meetings for their valuable contributions to this work. Invited participants who attended these meetings were:

- Tom Ascher, Tillamook County
- Mark Barnes, Mark R. Barnes
- Rainmar Bartl, City of Cannon Beach
- John Bischoff, City of Brookings
- John Boyd, Douglas County
- Peter Britz, CREST
- Bob Busch, Busch Geotechnical
- Marguerite Downy, City of Bandon
- Patty Everneden, Coos County
- Dave Foster, Stuntzer Engineering and Forestry
- Dave Carpenter, City of Seaside
- Steve Chesser, ACOE
- David Dickens, Northwest Oregon RCD
- Bill Eagle, Clatsop SWCD
- Jim Good, OSU
- Carl Cook, FEMA
- Doug Gless, H.G. Schlicker and Associates
- Rick Kienle, Jr., Northwest Geological Services
- Paul Komar, OSU
- Ron Larson, Handforth, Larson, and Barrrett Inc.
- Bill McDougal, OSU
- Chuck Nordstrom, Curry County
- Leonard Palmer, PSU
- Curt Peterson, PSU
- George Priest, DOGAMI
- Frank Reckendorf, Coastal Vegetation Specialist
- Roger Redfern, Professional Engineering Geologist
- Curt Schneider, Clatsop County
- Paul See, Paul D. See and Associates
- Ron Sonnevil, Terra Firma Geological Services Inc.
- Matt Spangler, Lincoln County
- Richard Ullian, City of Lincoln City
- Paul Visher, oceanfront property owner
- Larry Ward, LCOG
- Steve Williams, OPRD
- Laren Wolly, City of Gold Beach
- Eldon Wright, Clatsop SWCD

A special thanks to those of you who took the extra time and energy to review a draft of this work.

Shoreland Solutions wishes to thank Emily Toby of the Oregon Department of Land Conservation and Development for providing review and comment on all phases of this project. Shoreland Solutions also wishes to thank Jay Rasmussen of OCZMA for his input on all phases of this project as well as Georgia York of OCZMA for her efforts. Finally, thank you to all of the members of the OCZMA for their support of this project.

Cover and other illustrations by A. Rodman

Views expressed herein are those of Shoreland Solutions.

Funding for this work was provided by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under Section 309 of the Coastal Zone Management Act through the Oregon Department of Land Conservation and Development.

Appendix: Summary of Advisory Group Discussions

- As part of this project, advisory group meetings were held at five different locations - Corvallis, Portland, Cannon Beach, Newport, and Bandon- during the month of September 1995. The purpose of these meetings was to present some working concepts and solicit comments about what should be involved in littoral cell management planning. Participants at these meetings included city and county planners, state and federal agency representatives, engineers, geologists, geographers, oceanographers, vegetation specialists, oceanfront property owners and others. Views expressed by this diverse group of individuals are briefly summarized below.

- With respect to Oregon's existing system of oceanfront development and shore protection decision-making, concerns were raised about:

    - The quality of information used as a basis for decision-making. There is a heavy reliance on site-specific reports. Report content standards vary from jurisdiction to jurisdiction. Reports are prepared by investigators with varying amounts of expertise and experience. Reports are typically subject to limited review.

    - The extent to which adverse impacts to the adjacent shoreline and cumulative effects are accounted for - particularly in light of recent recognition of the importance of littoral cell sediment budgets and sand supply. Decisions regarding oceanfront development and shore protection are typically made on a site-specific, case-by-case basis. However, factors affecting shoreline stability tend to operate on an area-wide scale.

    - Governments' ability to make timely and predictable decisions. There is a recurring intergovernmental and interagency coordination problem, as a combination of local, state, and federal authorities share decision-making responsibilities. Disputes between interest groups over resource allocation and use, which are increasingly common, only serve to exacerbate this problem.

- Most individuals supported the suggestion that assessing and addressing hazard alleviation needs at the scale of individual littoral cells or subcells has the potential to address many of the concerns identified above.

- Most individuals favored an approach to littoral cell management planning that is narrow in focus and limited in scope. Specifically:

    - The reduction of risk from chronic hazards should be the primary objective of littoral cell management planning. However, depending on the circumstances, other objectives may need to be factored into decision-making. Examples other than hazard alleviation include maintenance and/or restoration of: natural resource values such as water quality, and fish and wildlife habitat; recreational, scenic, or cultural resource values; and economic opportunities.

- Oceanfront development and shore protection are the principal uses/activities that should be encompassed within littoral cell management plans.

- Expenditures of time, money, materials, etc. need to be minimized.

- The planning process should be directed at the local level, with the state providing technical as well as financial assistance; and

- Plans should be developed voluntarily and implemented within the existing regulatory and land use programs.

● A number of individuals suggested that the primary objective of littoral cell management planning should be to maintain and/or protect the sand supply. Stressing the importance of understanding littoral cell sediment budgets, this suggestion recognizes the value of sand as resource from economic, social, and environmental of perspectives For some littoral cells, active management of the sediment budget, and related concepts such as 'sand banking', may well be the crux of a beach and shore protection strategy.

● It was suggested that littoral cell management plans address catastrophic as well as chronic hazard alleviation needs and thus take a truly 'all hazards' approach...

● It was suggested that littoral cell management plans encompass a broad range of shoreline uses/activities. Specifically, it was suggested that the full set of uses/activities currently under the jurisdiction of OPRD need to be included in littoral cell management plans.

● It was suggested that greater attention be given to process as opposed to the substantive elements of littoral cell management planning. In this regard, most individuals expressed concerns about applying a 'full blown' special area management planning process to natural hazards management along the Oregon coast. Concerns about conducting such a large scale planning process included the lack of driving resource conflicts and therefore incentive, the lack of financial resources, the inability to complete the planning process in a timely manner, the desire not to revisit and in effect duplicate previous planning efforts, and the fear of creating an additional layer in the already complicated decision-making process.

● It was suggested that risk zone assessment needs to be an explicit step in the littoral cell management planning process. In this regard, no real consensus was reached as to what are the appropriate time frames with respect to potential risk. Most individuals favored longer time frames (i.e. 50 and 100 years) over shorter time frames (i.e. 30 and 60 years) as the longer time frames more accurately reflect the useful life of structures. It was suggested, however, that the use of shorter time frames would be consistent with FEMA's recent efforts pertaining to E-zone mapping.

- Most individuals preferred the use of terms such as 'high', 'moderate', and 'low' as opposed to '10-year', '50-year', '100-year' in regards to risk zone delineation, as there was concern that use of the latter terms to categorize potential risk conveyed a level of precision that was lacking.

- It was generally agreed that relative sea level rise is a factor that should be considered. However, the extent to which it is formally incorporated in risk assessment is likely to be limited.

- It was suggested that the effects of wind-driven sediment transport be given greater attention in the context of risk assessment.

- It was suggested that greater attention needs to be given to the delineation of planning boundaries, both the overall boundary and internal boundaries.

- The following were identified as criteria that can be used to establish where littoral cell management plans are most needed:

    - Social setting. Most individuals favored establishing areas with low levels of existing developments as a priority. However, some favored targeting areas with high levels of existing development.

    - Physical setting. Most individuals favored targeting a cell or subcell with limited variability, at least initially. However, others favored targeting a cell or multiple cells so as to cover the full spectrum of possibilities.

    - Sediment budget considerations. A number of individuals suggested that priority be given to areas where shoreline stability is particularly sensitive to sand supply. In this regard, there was general agreement that the current lack of detailed understanding of individual littoral cell sediment budgets is a problem.

    - Availability of information. Most individuals favored targeting areas with high levels of existing information, at least initially, as this would minimize the need to collect additional information. In this regard, there was general agreement that inventory information needed to be kept at a location or in a manner that is readily accessible to all potential users.

    - Interest. Clearly, for littoral cell management plans to be successful there needs to be a strong commitment at the community level.

- The following were identified as possible candidates for littoral cell management planning:

  - The Clatsop subcell, and the Cannon Beach, Rockaway, and Nestucca cells along the north Oregon coast;

  - The Lincoln City, Beverly Beach, and Newport cells along the central Oregon coast. The southern portion of the Newport littoral cell - from Yaquina Head to Seal Rock- was assigned a high priority. This is because: this mostly lightly developed subcell is experiencing high development pressure; the physical setting is relatively uniform (principally bluff-backed shoreline); sediment budget considerations are important and correspondingly unique sand management opportunities may exist; and, a great deal of inventory information already exists for this area.

  - The Gold Beach cell (between the Chetco and Windchuck Rivers) along the south Oregon coast.

- All participants agreed that attention needs to be given to citizen involvement and education. An educational program, that includes a series of workshops, should be developed and implemented. At least in Oregon, the concepts of littoral cells, sediment budgets, and sand supply are not well recognized by local officials, property owners, or the general public - in much the same way that wetlands and wetland values were relatively unknown 20 years ago. Besides wetlands, watershed management concepts were also identified as an analog. Sand management efforts underway in southern California might also be considered in this regard.

- Several individuals pointed out that the legal ramifications of littoral cell management planning need to be fully explored. Concerns were raised about liability, both from the standpoint of 'takings' as well as from the standpoint of failing to provide adequate safeguards. Exceptions or waivers to planning requirement were discussed in this regard.