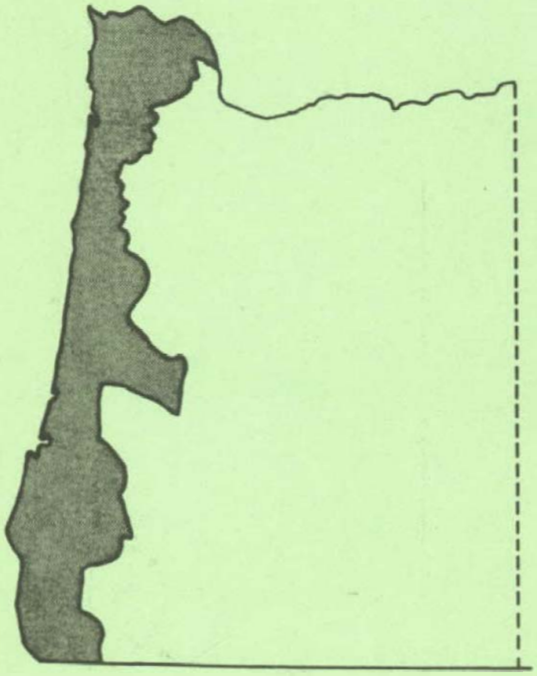
Miscellaneous Paper 17

GEOLOGIC HAZARDS INVENTORY

of the

OREGON COASTAL ZONE



ISSUED BY

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
R. E. CORCORAN, STATE GEOLOGIST

FOR

OREGON COASTAL CONSERVATION AND DEVELOPMENT COMMISSION

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1069 State Office Building, Portland, Oregon 97201

Miscellaneous Paper 17

GEOLOGIC HAZARDS INVENTORY OF THE OREGON COASTAL ZONE

John D. Beaulieu
Oregon Department of Geology and Mineral Industries
Paul W. Hughes and R. Kent Mothiot
Hughes and Associates, Inc., Consulting Geologists

Prepared for:
Oregon Coastal Conservation and Development Commission

1974

TABLE OF CONTENTS

ILLUSTRATIONS

INTRODUCTION

Purpose

As development continues, state and county officials and planners, developers, engineers, and private citizens are recognizing the need for information about geologic hazards. A knowledge of geologic hazards promotes safe, economical and efficient growth. It is the purpose of this study to provide a planning tool of use to all those engaged in land use planning along the Oregon coast. It is the further purpose to provide the Oregon Coastal Conservation and Development Commission with a document with which to formulate and evaluate land use policies for the coastal zone, a region which extends from the coast eastward to the crest of the Coast Range.

Implementation

Format:

This publication includes a text discussing the recognition, causes, potential impacts, and planning alternatives for eight major classes of geologic hazard. These are: (1) stream, wind, and wave erosion; (2) stream, wind, and wave deposition; (3) mass wasting; (4) adverse ground-water conditions; (5) adverse soil conditions; (6) adverse bedrock conditions; (7) stream and ocean flooding including tsunamis; and (8) earthquake potential. Also included in this document are a chapter relating landforms to geologic hazards, a chapter discussing land use, a listing of governmental agencies involved in the treatment of geologic hazards, and an extensive bibliography of references pertinent to geologic hazards. The text is thoroughly cross-referenced to assure maximum utility to the planner.

Land Use Planning:

Proper use of this document in land use planning is shown diagrammatically on the flow chart in Figure 1, and consists of the following procedure.

Step 1 - Define Task: Tasks may include the formulation of zoning ordinances, building codes, and community goals, the evaluation of proposed developments, or the dissemination of accurate information and advice to the populace or individual private citizens. In clearly defining the problem, the planner lays the groundwork for future decisions regarding the extent and direction of his investigation.

Step 2 - Locate Site: Location of the site or region on the Index Map enables the planner to accurately define the potential hazards (Step 3). It also directs him to pertinent literature listed in the bibliography and indicated on the Index Map.

Step 3 - Identify Potential Hazards: First, the landform at the site in question is identified. The Index Map and the definitions provided in the next chapter (Landforms and Associated Geologic Hazards) are designed for this purpose. To assure accuracy, reference to the literature (see Bibliography) and possibly on-site inspection by qualified personnel may be necessary. Because the various landforms have associated with them unique associations of geologic hazards (Table 1),

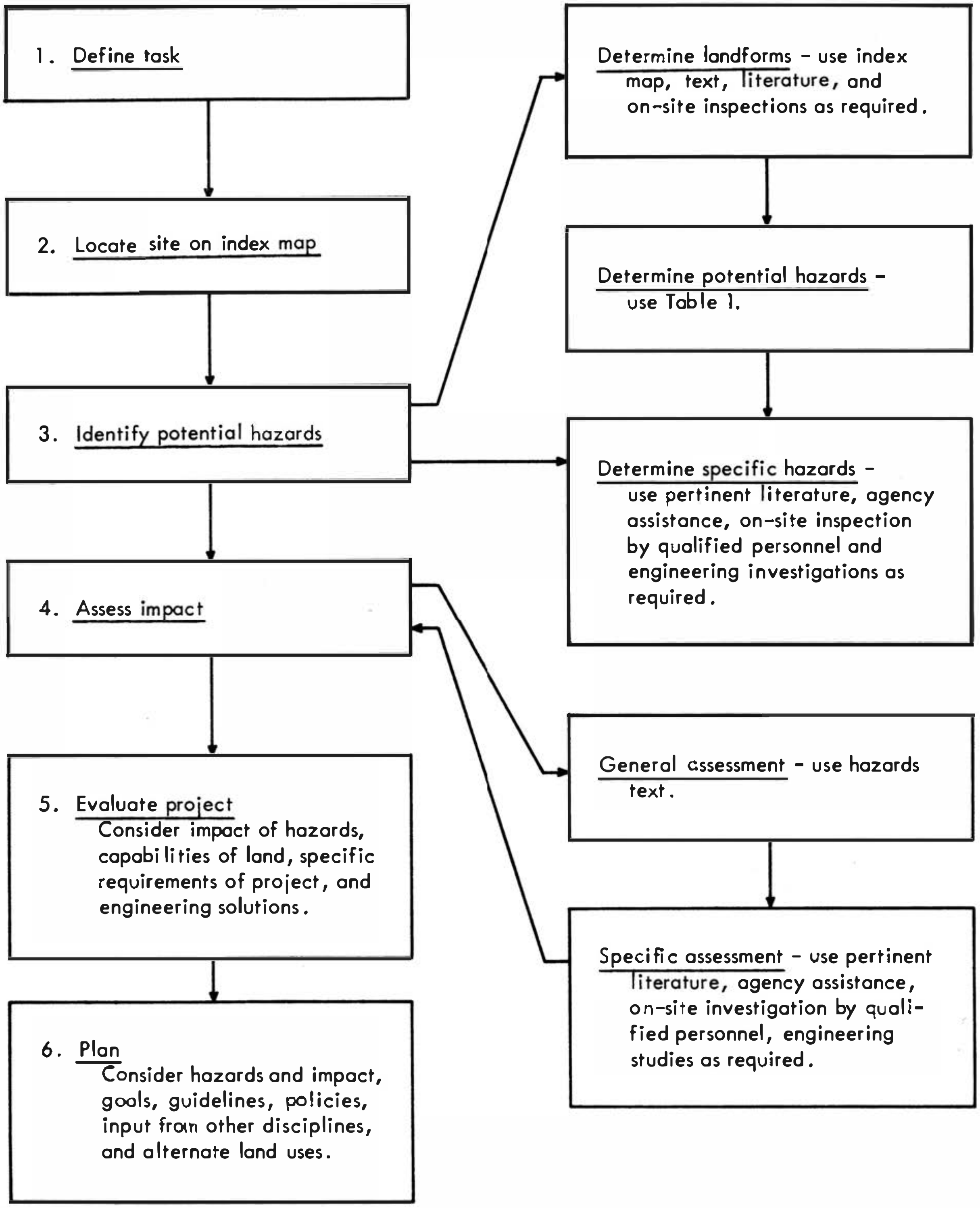


Figure 1. Flow chart showing the systematic use of this publication in land use planning.

it is essential that the landform be identified correctly.

Second, the potential hazards of the selected landform must be identified. This is readily accomplished through the use of Table 1.

Third, in most investigations the specific hazards actually present at the site must be identified. This involves use of the descriptions in the chapter on geologic hazards (Geologic Hazards - Recognition, Causes, Impact, and Recommendations), reference to the literature (see Bibliography), agency assistance (see Governmental Agencies), on-site investigation, or detailed engineering studies, depending upon the goals of the investigation and state or local policy.

Step 4 - Assess Impact: Each hazard has associated with it a variety of impacts depending upon land use. These are shown graphically on Table 2 (see Land Use) and are systematically discussed in more detail in Geologic Hazards - Recognition, Causes, Impact, and Recommendations.

More specific assessments of the impact of hazards at a particular site are obtained through proper use of the literature (see Bibliography), governmental services (see Governmental Agencies), on-site investigations by qualified personnel, or detailed engineering studies. The nature of the project and state or local policies largely determine the extent to which these sources of information are utilized.

Step 5 - Evaluate Project: The project is evaluated in light of its specific physical requirements and the potential impacts of the hazards present in the area. Engineering solutions are also considered (see Geologic Hazards -

Recognition, Causes, Impact, and Recommendations). Input by the potential developer may be significant in this stage.

The outcome is a direct statement concerning the feasibility of the project from the standpoint of economics and safety. The feasibility of many projects or plans may be determined largely by engineering solutions to specific problems or the implementation of other recommendations.

Step 6 - Plan: In addition to geologic hazards, final decisions regarding the use of the land must consider community goals, alternate land uses, state and local policies, and input from other disciplines. Such considerations should be based on a realistic assessment of the capabilities and liabilities of the land, however.

Policy Formulation:

Used in conjunction with a set of realistic goals, this publication can be invaluable in formulating acceptable land use policies on the local and regional level. Because policy formulation is a complex process involving many diverse interests and judgments, no flow chart is presented here. However, any process of policy formulation should exhibit the following four characteristics if it is to adequately speak to geologic conditions.

Coordination with Local Planning Efforts: Policies formulated on the regional level must be structured and worded in such a way as to compliment and assist the local planning effort. Requirements pertaining to geologic hazards must be keyed to the local planning process (Figure 1) to assure effectiveness.

Broad Scope: Land use policies pertaining to geologic hazards should be broad enough to incorporate all possible geologic hazards of significance. For example, policy statements should speak directly or indirectly to all hazards treated in this publication. The oversight of any one of them could lead to unnecessary future economic loss or even disaster.

In addition, the information presented in this report should form part of the basis for policies formulated for topics other than geologic hazards (e.g., estuaries and marshland). Reference to this publication can be of assistance in assuring adequate policies in these areas.

Feasibility: The formulation of sound policy statements requires sound judgment based upon a knowledge of the types of hazards, the potential impacts of the hazards, the variation of impacts as a function of land use, the types of engineering solutions available, and the types of management or planning solutions available. Although policies are designed in part to protect the public, they should not be based on overreactions arising from inadequate information regarding the magnitude of given hazards. To unnecessarily restrict growth and development through ignorance is equally as undesirable as to permit growth and development in unsuitable areas.

Observation-Oriented: Policies must not be phrased arbitrarily but must make provisions for local conditions. Policies must proceed not only on the basis of general land use classification but also on the basis of individual regional assessments or on-site investigations. Thus, it is the responsibility of the policymaker to determine the extent to which this publication, other publications, on-site investigations, agency assistance, and detailed engineering studies are required in problem-solving, as shown in Figure 1. Generally speaking, specific decisions regarding particular parcels of land will require the most rigorous investigations, and general decisions (e.g., zoning recommendations) regarding large regions will require only more generalized study.

Acknowledgments

The authors are grateful to the personnel of the Oregon Coastal Conservation and Development Commission, in particular, James F. Ross and Peter K. Watt, for their efforts in initiating this study and for their assistance in bringing it to completion. Funding for the project totaled $12,300 and was provided by the Oregon Coastal Conservation and Development Commission.

Appreciation is also extended to the staff of the State of Oregon Department of Geology and Mineral Industries for their help. Drafting was done by Steven R. Renoud and William H. Pokorny, editing by Carol S. Brookhyser.

LANDFORMS AND ASSOCIATED GEOLOGIC HAZARDS

A landform is a feature of the earth's surface formed by natural processes. The [variety of] landforms of coastal Oregon are the result of numerous geologic processes acting on differing rock types for varying periods of time. Each landform has associoted with it a unique association of geologic hazards as shown in Table 1. Accordingly, comprehensive assessment of geologic-hazards potential at a given site requires accurate landform recognition. This can be accomplished through the coordinated use of the index map and the following definitions.

Beaches are gently sloping zones of unconsolidated material that extend landward from the low-water line to a point where there is a definite change in rock type or landform. Beaches are easily recognized and occur between the headlands on the Oregon Coast. Dune fields or marshes commonly are situated immediately inland from beaches. The extremities of sand-spits are regarded as beach. Beaches should not be viewed in isolation, because they are actually but a small part of the total system of sand migration along the inner shelf and coastal region.

Dune land includes all areas underlain by loosely consolidated windblown sand. Areas presently being modified by the wind are termed active, and areas stabilized by vegetation are termed stable. Low-lying areas between dunes ore termed interdune areas and commonly contain marshes, streams and small lakes. Dune land is common along lorge inlets between beaches on the west and bedrock terrain on the east. Dune areas on spits are considered dune land. Stabilized dunes commonly mantle marine terraces

Table 1. Landforms and associated geologic hazards in the Oregon coastal region

Relative significance of hazard to land use

● High
◒ Moderate
○ Low
Not applicable

GEOLOGIC HAZARDS		LANDFORMS											
			Dune land					Marine terraces			Upland		
		Beaches	Active	Stable	Interdune	Lakes and marsh	Estuaries and tidal flats	Sedimentary platform	Volcanic platform	Stream bottom-land and terraces	Sedimentary	Volcanic	Sea cliff
EROSION	Stream	○	○	◒	○		○	○		◒	◒	◒	
	Wind	○	●	◒	○			○					
	Wave	●	●	●	◒		○	●	○				○
DEPOSITION	Stream					◒	◒			◒	◒	◒	
	Wind	○	◒	◒	◒			○					
	Wave	○											
MASS WASTING	Landslide			◒				●	○	○	●	◒	◒
	Mantle creep										●	○	◒
	Rockfall	○								○	○	●	●
GROUND WATER	High water table		○	○	◒			○	○	◒			
	Ponding				◒					◒	○		
	Salt water intrusion	○	◒	◒	◒	○	○						
	Pollution	○	●	●	●			◒	○	○	◒	◒	
SOIL	Compressible				●	●	●	○		◒			
	Weathered									◒			○
	Thin							○	◒		○	◒	◒
BED-ROCK	Lithology		◒	◒	◒			○	○		○	◒	◒
	Faults							○	○				
FLOODING	Stream				○	◒	●			●	◒	●	
	Tidal	●	◒	◒	◒		●						○
	Tsunami	●	◒	◒	◒		●	○	○				○
	EARTHQUAKES	○	○	○	○	●	●	○	○	◒	○	○	○

further complicating the study of that landform.

Lakes and marshes are inland bodies of standing water and are differentiated on the basis of depth and the amount of vegetation growing in them. Most lakes and marshes along the Oregon Coast are situated immediately inland from beaches and dune lands. They are formed by the natural impoundment of streams through dune growth or represent the intersection of the water table by local depressions.

Estuaries and tidal flats are tidal mouths of flooded rivers and tidal marshes respectively. Both are characterized by shallow water depths, direct connections with marine waters, influence of tidal action, and locally by moderate to great thickness of fine-grained and organic sediment. Estuaries are present at the mouths of all major streams along the Oregon coast; tidal marshes are scattered along much of the Oregon Coast.

Marine terraces are flat, gently sloping, elevated, wave-cut platforms brought to their present positions above the level of the ocean by regional uplift. Marine terraces are composed of volcanic bedrock in the headland areas and by sedimentary rock elsewhere. Commonly the bedrock is veneered by unconsolidated material including beach deposits, river deposits, and dune sand. Marine terraces are numerous along the central Oregon coast.

Stream terraces are elevated, flat-lying deposits of unconsolidated alluvium in stream valleys; they represent dissected remnants of the former flood plain and were formed when regional uplift caused the streams to cut downward at accelerated rates. Stream terraces, although too small to be shown individually on the map, are present intermittently along parts of most of the major streams [investigated in this study] in the Oregon Coastal Zone.

Upland is a general term for the moderately to steeply sloping regions of highland situated inland from the beaches, dune land, marine terraces, marshes, and lakes of the coastal area and up slope from the bottomlands of streams. The uplands are the most extensive landform of the study area and are underlain by Tertiary sedimentary and volcanic rock. With the exception of sea cliffs, headlands are included in the uplands in this study.

Sea cliffs are the steeply sloping oceanside faces of headlands. Examples include the seaward sides of Tillamook Head, Cascade Head, the Heceta Head. The significance of sea cliffs lies in the geologic hazards arising from undercutting by ocean waves. By convention the term sea cliff is also not applied to the wave-cut edges of marine terraces, which generally are separated from the ocean by a beach.

LAND USE

The terms land use and development refer to any use of the land by man and include the following activities:

1) The erection of large structures, including industrial and commercial establishments, dams, and nuclear power plants.

2) Regional activities, including high and low density subdivisions, forestry, agriculture, airports and reservations such as parks, game refuges, wilderness areas, and historical sites.

3) Linear constructions such as channels, pipelines, roads, highways, railroads, and power lines.

4) Material discharge such as solid waste disposal (landfills), septic tanks, and dredging spoil dumps.

5) Material extraction such as ground-water removal, metallic mining, and nonmetallic quarrying or open pit operations.

In Table 2 are given the relative impact of each type of hazard on each type of land use in the coastal region. After a listing of potential hazards for a given site is obtained from Table 1, a preliminary listing of significant hazards at a given site for a particular type of land use is derived from Table 2. Impacts and methods of treatment are discussed in more detail in the following chapter. It is emphasized that with proper engineering many of the impacts can be significantly reduced or eliminated.

Because the significance and impact of geologic hazards varies with 1) location, 2) type of development, and 3) engineering techniques available, Table 2 is useful in making preliminary decisions regarding policy formulation and land-use planning; it directs attention towards specific situations requiring consideration by the planner, and it directs attention away from situations not requiring special study.

Table 2. Relative impact of hazards on various types of land uses.

Relative significance of hazard to land use

● High
◒ Moderate
○ Low
N/A

GEOLOGIC HAZARDS	LAND USES																			
	Erection of Large Structures				Regional Uses					Linear Developments					Material Discharge			Material Extraction		
	Industrial	Commercial	Dams	Nuclear plants	High density subdivision	Low density residential	Airports	Forestry and crops	Reservations	Channels	Pipelines	Roads and highways	Railroads	Power lines	Solid waste disposal	Septic tanks	Dredge spoils	Ground water	Metallic mining	Nonmetallic mining
Erosion																				
Stream	●	●		◒	●	◒	○	●	○		◒	◒	◒	◒	◒		○		○	○
Wind	○	○			○	○	○	○	○						◒					○
Wave	●	●		●	●	●	○	○	○		◒	◒	◒	◒	○		◒			
Deposition																				
Stream	◒	◒	◒	◒	◒	◒		●	○	●		○								
Wind	○	○			◒	◒	◒		○	○		○								
Wave	○	○	○	◒	○	○	○		○	●	◒									
Mass wasting																				
Landslide	●	●	◒	●	●	●		◒	○		●	●	●	●	◒	◒			●	●
Mantle creep	●	●	○	●	●	◒		○	○		◒	◒	◒	◒	○	○			○	○
Rockfall	●	●	○	●	●	◒		○	●		●	●	●	◒					●	●
Ground water																				
High table	●	◒		●	●	◒			○						●	●			●	●
Ponding	◒	◒		○	●	◒	●	○	○			○			◒	●			○	○
Salt water																		●		
Pollution	○	○			●	●			○									●		
Soil																				
Compressible	●	●	●	●	●	●	●		○		◒	◒	◒	○						
Weathered	○	○		○	○	○					○				●	●				
Thin					○	○									●	●				
Bedrock																				
Lithology	●	○	●	●	◒	○									●	●				
Faults	○		○	●											○					
Flooding																				
Stream	●	●	○	●	●	◒	●	◒	○		○	◒	○	○	●	◒			○	◒
Tidal	●	●		●	●	◒	●	○	○		○	○	○	○	○	○		○		◒
Tsunami	●	●		●	●	●	●	○	●	○	○	○	○	○	○	○		○		◒
Earthquakes	◒	○	○	●	○	○	○		○		○	○	○	○	○				○	○

GEOLOGIC HAZARDS - RECOGNITION, CAUSES, IMPACTS AND RECOMMENDATIONS

Geologic processes or geologic conditions which constitutes a threat to any activities of man are geologic hazards. These include erosion, deposition, mass wasting, flooding, and various categories of ground water, soil and bedrock conditions.

In this chapter the definition, means of recognition, causes, impacts, and methods of dealing with 22 classes of geologic hazards are discussed. A universal recommendation for all hazardous areas is avoidance of the area if possible, agency consultation where appropriate, and reference to the pertinent literature. Actual selection of a course of action from the list of recommendations is the task of the planner and is made on an individual basis in light of economic, political, and sociologic conditions in addition to geologic settings and engineering technology.

Erosion

Erosion is the removal and transport of rock or soil materials by moving water. In the coastal zone of Oregon, erosion is subdivided into three categories: stream erosion, wind erosion, and wave erosion.

Stream erosion

General: Stream erosion is the loss of land by stream action and includes stream-bank erosion, channel scour, and gullying. Stream-bank erosion is recognized on the basis of steep river banks adjacent to deep parts of stream channels, bar formation on the opposite sides of streams, rigorous analysis of stream pattern geometry, and analysis of sequential sets of aerial photographs. Channel scour occurs in flash-flood channels, which are characterized by absence of a flood plain, and by coarse poorly sorted channel debris, steep gradient, and steep impermeable side slopes. Gullying is common in sloping areas of unprotected granular unconsolidated soil.

Causes of stream erosion include rapid precipitation, lack of vegetation, steep to moderate and sometimes gentle slopes, low infiltration rates, and erodibility of the bedrock or soil. Because land use can effect slope, vegetative cover, infiltration rate, and degree of consolidation, it is a primary factor in gullying in areas of development.

Impact: The impacts of stream erosion may include the undercutting of structures of all sizes, the interruption of linear developments such as highways, railroads, and pipelines, the loss of topsoil in forestry and agricultural areas, increased sediment load, degradiation of water quality, and the destruction of spawning grounds. Pollution of streams can result if landfill operations are eroded. Mountain roads in regions of flash flooding are especially prone to washouts.

Recommendations: Preventative actions may include the maintenance of vegetation in critical areas, the stabilization of stream banks with riprap or vegetation, the covering of bare slopes with matting, jute, grass, or asphalt, the accommodation of increased runoff in areas of development, and possibly restriction of construction to the dry season in critical areas. In areas analogous to coastal Oregon, urbanization has been observed to increase runoff by a factor of 3 and to increase sediment yields by factors of 65 to 85. Sloping stabilized duneland is particularly sensitive to gullying with the loss of vegetation.

Management and planning actions may include engineering studies including erodibility maps for large developments, and requirements for proper engineering of logging roads including provisions for the placing of riprap, cribbing and culverts. Watershed management may include specifications for planting, reforesting, proper rowing and slashing, contour strip logging, the establishment of buffer strips near streams, and the construction of diversion channels in small areas of especially critical concern.

Wind Erosion

General: Wind erosion is restricted to areas of moderate to high wind velocities, abundant unconsolidated material, and lack of stabilizing factors such as vegetation. Included are beach areas, dune land, and construction sites.

Impact: Wind erosion can undermine structures and utilities, abrade exterior surfaces, remove valuable soil, pollute nearby areas, and lead to general irritation and inconvenience to nearby residents. Wind erosion of improperly operated landfill sites can lead to severe degradation of the environment in adjacent areas.

Recommendations: Provisions to reduce wind erosion may include the maintenance of vegetation in presently stabilized areas and the planting of dune grass and appropriate shrubs and trees in presently active dune areas. In the more frequented parts of dune land parks, visitors should be encouraged to stay on established paths and dune buggies should be restricted from stabilized areas. Engineering reports for large developments in dune land areas should include a consideration of the wind-erosion hazard for the construction stage as well as the final development. Efforts should be made to minimize topographic modifications in dune land areas.

Wave Erosion

General: Wave erosion is the removal of shoreline material by wave action. It is a major hazard along much of the Oregon coastline and also is a minor consideration along the banks of estuaries and lakes. Areas of coastal wave erosion are characterized by regions of relatively steep narrow beaches, the absence of well-developed berms and the presence of steep seacliffs devoid of vegetation. Also useful in delineating areas of high wave-erosion potential are local records, sequential sets of photographs (surface and aerial), and detailed on-site monitoring.

Causes of wave erosion along the coast may include lateral migration of rhythmic coastal topography (sand bars and cusps), climatic fluctuations, severe storms, and interruption of the sand budget by delta growth or recession, groins, jetties, dredging, and to a limited extent, by certain types of excavation nearby. The determination of the actual cause of wave erosion at a particular site is generally a very rigorous procedure.

Impact: Rates of coastal erosion vary from a few inches to a few feet per year along terraces of sedimentary rock but approach rates of 8 feet per year locally. Erosion rates in regions of volcanic rock are considerably less. Erosion rates in areas of unconsolidated dune land may reach 100 feet per year over short periods of time. Total destruction of all structures on the undercut terrain is universal.

Recommendations: Provisions should be made so that coastal erosion rates are considered in the location of all developments in regions of coastal erosion. Erosion rates can be derived from sequential sets of aerial photographs, county records, interviews, and on-site monitoring. Structures generally should be set back from the seacliff an adequate distance to assure safety and utility for the established lifetime of the structure.

Engineering solutions may include the placement of properly engineered riprap or the construction of seawalls, jetties, or groins. Because jetties constitute significant terrain modifications, however, they may initiate undesired changes nearby (see Wave Deposition). Thus, the secondary effects of jetties should be thoroughly investigated prior to installation.

Wave erosion potential should be incorporated into the design of all pipelines leading into the ocean, including those for sewage disposal, pulp disposal, and reactor cooling water. Within estuaries, dredge spoils should be properly disposed of to avoid erosion and redistribution of toxic material or material with high biochemical oxygen demands (BOD). Tidal and storm action or by waves generated by passing boats are active agents of erosion.

Deposition

Deposition is the laying down of rock or soil materials by wind or water. In the coastal region, deposition is subdivided into stream deposition, wind deposition, and wave deposition. Deposition is caused by a loss in the carrying capacity of the transporting medium.

Stream Deposition

General: Stream deposition occurs in slack water areas such as pools, marshes, the inner parts of meanders, behind obstructions, on flood plains, and in areas of decreasing stream gradient. Man-induced changes in the velocity, discharge, width, depth, load, and channel roughness result in a change of carrying capacity, which may in turn lead to deposition.

Impact: Stream deposition may lead to sediment accumulation in industrial and commercial structures, in houses, and on landscaped areas or crop land. It may clog water intake fixtures for industry, dams, and reactors. Stream deposition may also reduce dam reservoir capacity, destroy breeding grounds for fish, hinder navigation, and increase dredging costs. The formation of gravel bars may direct streamflow against river banks causing stream erosion and the loss of valuable land. In areas of flash flooding, debris commonly buries roads and may be a threat to other structures. In construction areas, material eroded from farther upslope by gullying can cause considerable damage where it is deposited downslope.

Recommendations: Stream deposition can be avoided by minimizing erosion in the sources of sediment supply through proper management (see Stream Erosion). This is particularly important in areas of logging or construction. The use of settling ponds can concentrate deposition into regions of minimal impact.

Stream deposition can be minimized by removing snags, clearing log jams, and mining gravel bars where appropriate. Dredging operations and other types of channel engineering are sometimes necessary in stream reaches of low gradient such as estuaries.

Wind Deposition

General: Where wind velocity is abruptly reduced, carrying capacity is diminished and blowing sand or other debris is deposited. Obstructions which promote wind deposition include vegetation, changes of topography, and man-made structures. Wind deposition is significant in beach and dune land areas and is recognized on the basis of dune structures and on the basis of partially buried structures such as trees.

Impact: Wind deposition can bury roads, pipelines, parking lots, lawns, and other low-relief developments and can partially bury structures of greater relief, such as houses. Sand deposition on roads, railroads, and airport runways can be a threat to safety. Over long periods of time, sand deposition can fill in stream and river channels and small lakes.

Recommendations: Wind deposition can be avoided by stabilizing the sources of sediment supply (see Wind Erosion). However, since the beaches are continually supplying additional sand in many areas, additional measures are commonly necessary.

Terrain modification should be discouraged in critical areas. Man-made depressions are sites of potential sand accumulation. Large structures in dune land and regions of sand precipitation are also sites around which sand readily accumulates. Locally the establishment of dune grass or the construction of sand fences can promote wind deposition into areas of minimal impact, thus reducing the impact in more critical areas.

Wave Deposition

General: The carrying capacity of waves is significantly altered by modifications of the coastal topography or bathymetry. Wave deposition may be induced by natural or man-made changes in the coastline of a temporary or permanent nature. Recognition of problem areas rests fundamentally on viewing the coastline as a system of sediment transport in delicate equilibrium and in viewing changes of the coastline in terms of their potential effect on the carrying capacity of waves.

Impact: Wave deposition can fill in the mouths of estuaries, rendering them unnavigable, alter bathymetry, presenting a hazard to boaters and commercial fishing, and under extreme conditions, it can actually isolate industry or homes from the beach, sometimes by a thousand feet or more. In areas of recent dredging, deposition in the excavation results in a temporary interruption of sand transport along the coastline; this may lead to temporary erosion along the adjacent coastline until the sand budget re-establishes equilibrium.

Recommendations: Entrances to estuaries can be maintained by the construction of jetties and by on-going dredging operations. The impact of these measures on the littoral transport of sand should be evaluated beforehand to assure that modified patterns of deposition and erosion on the adjacent coastline are within acceptable limits. The placing of dredge spoils, especially in estuaries, should be properly managed to assure that the material is not redistributed by wave action to the detriment of adjacent land use (see Wave Erosion).

Mass Wasting

Mass wasting is the slow or rapid downslope movement of rock, soil, or fill under the influence of gravity. In contrast to erosion, the influence of water is of secondary importance. Mass wasting is favored by heavy precipitation, penetrative weathering and moderate to steep slopes. In the coastal region of Oregon, mass wasting is subdivided into three main categories: landslides, mantle creep, and rockfall. If rapid, water-induced, and not triggered by the activities of man, mass wasting comes under the definition of mudslide as defined by statute in the National Flood Insurance Act as appended in 1969.

Landslides

General: The rapid downslope movement of earth material is termed landsliding. Landslides can occur on nearly all angles of slope, but are most common on slopes varying between approximately 25 percent and 50 percent. Landslide areas are recognized on the basis of irregular to hummocky topography, sag ponds, irregular drainage patterns, disordered distribution of soil types, cracked ground, headscarps, tilted trees, deceased slope relative to similar adjacent terrain, or unique vegetative cover. Areas of landsliding are transitional with areas of mantle creep and are distinguished from them on the basis of the greater abundance of slide features. Landslides are commonly triggered by an increase of load at the head of the slide, a decrease of support at the toe of the slide, or an increase of pore pressure within the slide.

Impact: Active landslides can damage or destroy most structures of man including industrial and commercial buildings, homes, and linear developments including roads, highways, pipelines, and communication cables. For large projects, such as dams and nuclear power plants, engineering solutions may be possible. Where movement is restricted to a few tens of feet in depth, it may even be removed by grading; however, where slides are particularly deep, as along the coast, this solution is not possible.

Active slides can be generated by acts of man which alter the balance of nature. Excavations, cuts, fills, and drainage modifications may decrease the stability of an area and initiate sliding. Water introduced into the subsurface by drain fields, septic tanks, and improper handling of runoff may also initiate slides.

Recommendations: Generally speaking, little or no development should be allowed in areas of active sliding. Restrictions on areas of landslide topography, historic landslides, and other areas of potential sliding are discussed under Mantle Creep. Where active landslides occur and cause damage, repair crews should not be dispatched until qualified personnel pronounce the area safe. Usually this involves at least waiting for storm activity to subside.

Mantle Creep

General: Mantle creep (also soil creep) is the slow movement of earth material downslope over prolonged periods of time. It generally is restricted to moderate slopes varying between approximately 10 percent and 25 percent, but also occurs in association with active and historic landslides on steeper slopes. Mantle creep is similar to landsliding in most respects except for a much slower rate of movement. It may involve soil, weathered bedrock, or both.

Diagnostic features are the same as those for landslides, but are much more subtle in their development, owing to the lesser rates of movement. Irregularities of slope, drainage, soil distribution, and vegetative cover are the main criteria for recognition.

Impact: The impact of mantle creep is particularly bothersome because it is fairly difficult to recognize, and the effects of it are sometimes not experienced for a considerable time after development has been completed. Thus, gradual mantle movement may slowly crack foundations, destroy structures, and warp linear features such as pipelines. Sections of road may move slowly downslope at rates of only a few inches per year and necessitate costly and repeated repair. Disordered drainage and variable ground water and soil conditions in areas of mantle creep (landslide topography) may lead to septic tank failures, landfill failures, and differential settling of structures.

Slow residential development in areas of mantle creep may remain unaffected for many years, only to be damaged at a later date as the cumulative effects of drainage, infiltration, and vegetation modifications exceed the stability requirements of the region. Active landslides may be initiated in areas of mantle creep through improper excavation, landfilling, drainage modification, landscaping, and logging techniques.

Recommendations: For urbanizing areas threatened by mantle creep and associated landslides, the National Flood Insurance Act as appended in 1969 should be inacted. The U. S. Department of Housing and Urban Development oversees this Act. Engineering studies should be required of all large structures and regional developments where mass wasting is a potential hazard. Zoning regulations should incorporate the grading standards of the Uniform Building Code and the density and nature of developments should be keyed to slide potential.

All excavations, fills, drainage changes, and vegetation removal programs in areas of mass-movement topography should be engineered to minimize the possibility of sliding. Road construction has been shown to be a great contributor to landsliding in slide-prone areas. For particularly large money-intensive projects, actual removal of the sliding material may be feasible if the depth of sliding is not excessive.

For small projects in isolated areas, education of the developer on an individual basis may be all that is required.

Rockfall

General: Rockfall is the free fall or nearly free fall of bedrock material down a cliff or relatively steep slope (generally greater than 50 percent) and includes avalanches and similar processes. Rockfall is generally restricted to volcanic bedrock terrain in the uplands and along sea cliffs. Areas of rockfall potential are recognized on the basis of steep cliffs, talus, unvegetated debris trails, and loose overhangs.

Impact: Because large regional structures and developments are restricted to gently sloping regions, they are generally not threatened by rockfall. Rockfall, however, is a threat to highways, railroads, pipelines, and other developments in steeper areas and can be a threat to the safety of hikers, beachcombers, loggers, and miners.

Recommendations: The danger of rockfall can be minimized through proper engineering of all projects in areas of rockfall potential. Excavating, placing of fills, and blasting should be conducted only after the potential for rockfall has been accommodated. Along highways and railroads the use of screens and earth ridges can reduce the impact of rockfall. Warning signs should be placed in all regions of rockfall potential in parks and reservations. These include beaches at the foot of headlands and some of the steeper bedrock trails of upland areas.

Ground-Water Hazards

Water which fills the open spaces in rock and soil beneath the land surface is termed ground water. The top of the zone of saturation is the water table. It conforms in a general way with the surface topography, but is nearest the surface in depressions and farthest from the surface beneath topographic highs. Hazards associated with the ground water in the coastal zone of Oregon are subdivided into four categories: high water table, ponding, salt-water intrusion, and pollution.

High Water Table

General: Water table situated high enough to have an adverse affect on the activities of man is termed high water table. It is recognized on the basis of well-log data and surficial and soil features such as marshy ground, the presence of reeds, or marsh grass, extremely flat topography or depressions, high organic content in the soil, and black to blue-gray soil mottling. The actual depth to the water table which constitutes a hazard is a function of the type of land use under consideration.

Impact: High water table can lead to flooding of basements, underpasses, and other subsurface facilities, flotation of bouyant structures such as pipelines, tanks, swimming pools, and newly installed septic tanks, differential settlement of large to moderately sized structures, and complications in the installation of underground facilities such as utilities and pipelines. Included is the caving of excavations.

Other problems include the possibility of shrink-swell related damage to structures initiated when the soil responds to rising and falling of the water table, liquefaction phenomena during earthquakes, and threats to water quality in areas of solid-waste disposal. Septic tanks generally should not be installed where the water table rises to within six feet of the ground surface.

Recommendations: Developments in regions of high water table should be restricted to those forms of land use that are either compatible with the characteristics of the land or that can be engineered to provide an adequate level of safety. Engineering studies for large structures generally take this into consideration, but housing developers and individual homebuilders sometimes do not. Linear developments, such as pipelines and roads, which must cross regions of high water table should be properly engineered.

Engineering solutions include the use of piling and drainage tiles as well as provisions for inhibiting caving and avoiding flotation of structures. Restriction of construction to the dry season may be necessary in some areas.

Ponding

General: Ponding is the local accumulation of runoff or rain water owing to extremely low slopes, topographic restrictions, or low permeability of the underlying soil or bedrock. It constitutes a special case of high ground water in the sense that it represents perched water conditions in which the water table lies above the surface of the ground. Ponding is recognized by the surficial accumulation of rainwater in the wet season, by the presence during the dry season of such marsh features as abundant reed grass, and the occurrence of black or black to blue-gray mottled soils.

Impact: Many of the impacts of ponding are similar to those of high ground water discussed previously. In addition, ponding can lead to surficial flooding, damage of underground installations, and failure of waste discharge systems such as septic tanks. Regional activities of man which significantly reduce infiltration rates in areas of extremely low slope and poor drainage can generate significant ponding hazards. Impacts may include damage to subdivisions located in alluvial valleys and threots to safety on improperly drained airport runways.

Recommendations: Ponding hazards can be handled through a combination of engineering solutions and preventive measures. Adequate handling of runoff should be required for all regional developments which alter infiltration rates in areas susceptible to ponding. These include airports, subdivisions, and other large structures in flat-lying areas. Provisions should also be made to assure that the disposed runoff does not adversely affect adjacent land use.

Local engineering solutions may include the placing of fills or the installation of drainage fields in areas where slope is adequate to assure removal of the runoff. Compaction of flooded fields should be avoided so that agricultural productivity of the soil is not threatened.

Landfills and septic tanks should not be allowed in regions of ponding unless engineering solutions are available. Contamination of ponded rainwater through malfunction of waste-discharge systems can lead to ground-water or surface-water pollution.

The widespread use of levees to prevent flooding of river lowlands by streams has the adverse affect of restricting the runoff of rainwater. In critical areas, the use of one-way floodgates, ditches, and drain tiles possibly could increase the use potential of the land.

Salt-Water Intrusion

General: Because fresh water is less dense than salt water, it floats on top of salt water in the subsurface. In beach and dune areas, therefore, the water table consists of fresh water overlying salt water at depth. Over-withdrawal of the fresh water can lead to encroachment of salt water into wells as it moves inland to replace the fresh water that has been removed. This phenomenon is termed salt-water intrusion.

Impact: Impact of salt-water intrusion can include permanent or temporary degradation of the water supply, corrosion of pumping facilities, and monetary loss if pumping facilities have to be abandoned.

Recommendations: Steps for preventing salt-water intrusion include conducting adequate hydrology studies to define the proper spacing and yield of water wells and a commitment to base development on the results of these studies. The U. S. Geological Survey has conducted ground-water studies in the Clatsop Dunes, North Coos Bay, and Florence areas. Deep wells and wells on the western edge of the dunes would be the first to experience salt-water intrusion.

Salt-water contamination of wells in the uplands results from the accidental tapping of connate sea water rather than true salt-water intrusion. The only solution is to drill a new well.

Ground-Water Pollution

General: Ground-water pollution is technically not a geologic hazard in that the main cause of the problem lies in the activities of man rather than acts of nature. Because an understanding of geologic conditions is fundamental to the prevention or treatment of ground-water pollution, however, it is included here.

Impact: When ground water becomes unusable through pollution, the impact on all forms of land use which draw upon the ground-water supplies, including industry, commercial businesses, homes, and farms, can be severe.

Recommendations: Provisions should be made to assure that recharge areas for ground-water aquifers are protected from pollution. The unconsolidated sand which overlies the large ground-water reserves of the coastal areas are characterized by high infiltration rates and are particularly susceptible to pollution. Waste discharge operations, such as landfills, septic tanks, and industrial waste lagoons, are not recommended for these areas under most conditions.

River valley areas also are subject to ground-water pollution through the improper location of landfills. Although grazing and application of fertilizers also pose a threat to such areas, no degradation of water quality has been traced to these uses as yet. The installation of more intensive point sources of pollution, such as feed lots, is not advisable, however.

Proper installation of well casings also is required to prevent ground-water pollution at the point of extraction. Improper installation can lead to the entry of surface pollutants into the subsurface along the casing of the well.

Soils

From the engineering standpoint, soils are the unconsolidated earth material that overlies bedrock. Because the majority of man's activities involve the uppermost five to ten feet of the earth's surface, consideration of some of the problems posed by the soil are pertinent to planning. Here limitations of soils are subdivided into three categories: compressible soils, weathered soils, and thin soils. In addition, highly permeable soils are not suited to certain uses (see Ground-Water Pollution).

Compressible Soils

General: Compressible soils are soils which undergo a significant decrease in volume when subjected to loading. They commonly contain organic matter or certain types of clay which release water under pressure. Compressible soils are associated with marsh land, tidal flats, estuaries, lake margins, and interdunel areas.

Compressible soils are recognized by their high organic content and topographic setting. Because compressible soils may be present in the subsurface, coring and soil testing is necessary for most developments in regions where they may be present.

Impact: Construction on compressible soils can result in differential settling of a wide variety of structures including large buildings, homes, roads, railroads, airport runways, and pipelines. Because compressible soils are associated with high water content, liquefaction during earthquakes and caving during excavation are also possible. Finally, construction of large structures, such as roadfills, at one locality may force water to the side, causing damage to smaller structures in adjacent areas.

Recommendations: Proper engineering investigations should precede all medium to large construction in regions of possible compressible soils. Engineering solutions include excavation and backfilling with more suitable material, preloading, and the use of piling, or spread footings, depending upon the nature of the specific structure being considered and the degree of severity of the hazard. For individual homes, the fill material needed to avoid flooding is commonly sufficient to accommodate the hazard of differential settling.

Weathered Soils

General: Weathering is the process by which rock material is broken down chemically and physically to form soil. It includes chemical breakdown and reconstitution, physical disintegration, and leaching. Weathered soils generally do not constitute a hazard, but commonly specific types of soil are poorly suited to certain types of use. In the Oregon coastal zone the clay-rich soils overlying fine-grained sedimentary rocks exhibit low slope stability, low permeability, and high shrink-swell ratios in places.

Impact: The impact of low slope stability is discussed under Mass Movement. High shrink-swell ratios can result in damage to structures of all sizes. Low permeabilities can lead to septic tank failure. In most instances, the high clay content of the soil resulting from weathering is fundamental in the development of the hazard.

Recommendations: Engineering studies for moderate to large-sized structures include the investigation of soil related problems. Technology or actual removal of the soils commonly solve the problems posed by poor soils. Proper site investigations are needed prior to septic tank installation. Regulations on septic tank installation are handled by the Oregon Department of Environmental Quality and by county sanitarians. Low-lying, deeply weathered regions in areas of fine-grained sedimentary rock are especially prone to soils hazards arising from pervasive weathering.

Thin Soils

General: Thin soils are soils with thicknesses that are not sufficient to handle a desired type of land use adequately. Like other soils problems, thin soils are recognized by site investigations and through the use of soils mapping available through the U. S. Soils Conservation Service, federal and state forest services, and private logging companies. Thin soils are most prominent in the volcanic uplands, but also are developed on sedimentary rocks of low permeability.

Impact: Thin soils may be a contributing factor to flash flooding in upland areas and, owing to the low permeability of the underlying bedrock, are not suited to septic tank use. Underground facilities may require blasting, depending on the nature of the underlying bedrock. Thin soils are not suited to most forms of agriculture.

Recommendations: For septic tank and landfill utilization, the thickness of the soils in addition to their texture must be considered. Costs analyses for subsurface installations, including basements, pipelines, or utility lines, must consider the increased costs resulting from thin soils. Developments in areas of thin soil must be designed to accommodate the flash flooding or ponding threats posed by the low infiltration rates of the underlying bedrock.

Bedrock

Bedrock is the consolidated material that underlies the soil zone as defined by the engineer (see Soils). Weathering is minimal and is concentrated along joints and fault zones. In the Oregon coastal zone, bedrock consists primarily of sandstone, mudstone, and various kinds of volcanic rock. Properties of bedrock can cause serious difficulties to certain types of development if not considered in the planning process. Bedrock hazards are grouped into two categories: rock type, and structure.

Rock Type

General: The properties of bedrock are directly related to numerous active geologic processes such as flooding and mass movement. These are discussed in other sections. Hazards of interest here are the static properties of bedrock, such as bearing strength, heterogeneity, and permeability. Although a knowledge of general rock type at a given site is essential for a general knowledge of rock properties, detailed on-site investigations are needed to assess the suitability of a site to a particular type of development.

Impact: Low foundation strength can cause damage to large- and moderate-sized structures such as industrial buildings, dams, nuclear power plants, and commercial structures. Low permeability can lead to septic tank failure and high runoff or ponding. High permeability can lead to landfill failure. High excavation costs can be the deciding factor in the installation of moderately priced, noncritical developments such as homes and secondary roads, but is generally of secondary importance in the construction of highways, pipelines, and railroads.

Recommendations: Where engineering properties of the bedrock are a prime consideration in development, engineering studies are generally conducted by the interested developer or agency. It is essential that variations in the properties of given types of bedrock be considered in such studies. Thus, core data and boring logs at one site are not adequate for the evaluation of another site even it if is in the same kind of bedrock. In policy formulation and in regional planning, it is necessary that planners be aware of the types of restrictions posed by the various types of bedrock so that planning proposals can be realistically keyed to the capabilities of the land.

Structure

General: Structure refers to the general disposition of the rock types in a given area and includes direction and angle of dip, nature of the bedding, and the presence or absence of faults or joints. The discontinuities and orientations of rock bodies defined by structure commonly affect land use. Recognition of structures is done on an individual basis using standard geologic mapping techniques including aerial photo interpretation, on-site mapping, and regional reconnaissance mapping. The basic data are recorded on geologic maps.

Impact: The impact of bedrock structure varies with the particular type of structure and the land use under consideration. Dipping, well-defined bedding planes can undergo shear failure and cause landslides if undercut by stream action or excavation. In the coastal zone this is a hazard in regions underlain by the Tyee Formation or similar rock units composed of sharply alternating beds of hard sandstone and semi-consolidated siltstone. Volcanic rock overlying softer sedimentary rock also can fail in this manner.

Bedrock jointing can lead to reservoir loss behind dams, piping beneath dams, failure of landfill disposal sites, and general danger in steeply sloping area owing to increased rockfall potential (see Rockfall).

Movement along faults can cause serious damage to all structures situated on or near them. However, it is emphasized that there are no known active faults exposed at the earth's surface in the coastal zone of Oregon. This fact, in addition to the experiences of over 100 years of development along the Oregon coast, underscore the conclusion that actual mapped faults are of no concern to most forms of development. Earthquakes originating from faults in the subsurface are of concern, however, and are discussed in a separate section (see Earthquakes).

The impact of mapped faults lies primarily in their similarity to joints in that they may alter bearing strength, permeability, or other static properties of the bedrock. They are also of critical concern to the location of nuclear reactors because the possibility of future movement, no matter how remote, is a consideration which overrides all others for this type of development. Also, intensive study associated with reactor siting may uncover active faults not recognized at the present time.

Recommendations: Where structural properties of the bedrock are a consideration in development, engineering studies are generally conducted by the interested developer. County road construction and local landfill siting should be conducted in light of the limitations posed by bedrock structure. Nuclear siting investigations are conducted by the utilities companies and are overseen by the Oregon Nuclear and Thermal Energy Council.

Flooding

Flooding is the inundation of the land resulting from high stream or ocean levels. It is subdivided into three categories: stream flooding, ocean flooding, and tsunamis.

Stream Flooding

General: Stream flooding is the result of heavy rains falling upon steep and impermeable slopes. It can be aggravated by decreased infiltration owing to frozen ground or modified land use. Rarely landslides block streams, generating the threat of catastrophic flooding downstream.

Using various computer models, areas subject to stream flooding are delineated by the U. S. Army Corps of Engineers, the Soils Conservation Service, and the U. S. Geological Survey. The programs are capable of producing flood maps for any desired frequency of occurrence.

In the absence of statistical models, maps showing areas of past flooding can be assembled using flood records, high water marks, interviews, newspaper clippings, and aerial and surface photographs. For areas in which there is little or no recorded data, regions of estimated possible flooding can be deduced from soils, vegetation patterns, topographic expression, and the distribution of flood debris.

Impact: Stream flooding can damage developments through the effects of moving water, standing water, erosion, and siltation (see Stream Erosion, Stream Deposition). Industrial and commercial establishments, homes, and other structures can experience considerable structural damage. Airports can be rendered unusable and transportation by highway or road can be severed. Flooding by streams constitutes one of the major geologic hazards of the coastal area.

Recommendations: Methods of dealing with floods are numerous and must be selected on the basis of land use, specific flood potential, economic restraints, and goals.

Regulatory measures require adequate flood data. For areas in which flood-plain zoning, subdivision codes, and building codes (provisions for floor elevations, storage restrictions, waterproofing, and anchoring) are contemplated, sophisticated flood studies should be conducted. These should include a delineation of the floodway and the floodway fringe. Owing to current activity in the floodway, its development should be restricted to open use such as parks, parking lots, and reservations.

Emergency preparedness measures may include implementation of the National Flood Insurance Act of 1968 (administered by the U. S. Department of Housing and Urban Development and coordinated in Oregon by the State Water Resources Board), and the organization of effective floodwarning procedures through close cooperation between the U. S. Army Corps of Engineers, the National Weather Service, and local personnel.

Structural methods of dealing with floods may include the construction of levees, dikes, dams, and revetments, and channel improvements. Generally land use must justify the investment. Water-treatment plants should be properly located or constructed to withstand flooding. Sewage treatment plants should be located or constructed in such a way as to prevent pollution during flooding.

Post-flood actions may include the Governor's decloring the area a disaster, an action which makes possible the release of funds for restoration of public facilities, river repair, and low-interest loans to individuals and small businesses.

Provisions should possibly be made to assure that prospective home owners are not victimized by their lack of knowledge of local flood potential. This might include disclosure statements, the posting of flood warnings, general education programs, or other disclosure policies on the county or city level.

Ocean Flooding

General: Flooding caused by high tides or storm surges is termed ocean flooding. Typically the elevated sea prohibits stream drainage and thus aggravates stream flooding as well. Tidal flooding is a periodic occurrence in the tidal marshes bordering estuaries and dune lands, but also can occur at higher elevations. When it does, it constitutes a geologic hazard.

The highest predicted tide for the Oregon Coast is 10.3 feet (sea level is 4.1 feet), and the highest recorded storm surge elevated sea level 4.2 feet above the predicted tide at the time it occurred. The highest measured tide to date was 12.63 feet. It included a high lunar tide plus a moderate storm surge. The highest projected tide that can occur is a combination of the highest predicted tide and the highest observed storm surge. It is 14.5 feet, or 10.4 feet above mean sea level.

Ocean flooding occurs during the winter months and during the high spring tides if accompanied by regional storm activity. Prediction of ocean flooding is easily accomplished through the use of tide tables and weather predictions.

Impact: The impact of ocean flooding is similar to that of stream flooding with the exception of the additional hazard of salt water damage to fixtures and crop land.

Recommendations: The significance of ocean flooding is that it aggravates lowland flooding along streams. Thus it must be considered in all flood models used for stream-flood zoning. In addition, because ocean flooding prevents streams from draining properly, dredging and channel modifications alone will not solve the stream-flood problems of the lower reaches of coastal Oregon streams. For restrictions on development, see Tsunami.

Tsumami

General: Tsunami is the term applied to waves generated at sea by earthquakes or particularly violent volcanic activity. At sea, tsunamis are difficult to detect because of their long wave lengths (a hundred miles or more) and low amplitudes (seldom exceeding a foot or so). Velocity is determined by the depth of the ocean and approaches 450 miles per hour in parts of the Pacific Ocean. As tsunamis approach land, the shallower depths cause the water to pile upon itself, thus increasing the amplitude. In some parts of the world, wave heights of 100 feet are recorded in the literature.

Large tsunamis are generated by large earthquakes (Richter magnitude of 7.5 or greater) having a shallow focus (a few tens of miles) and involving large vertical displacements (several feet or more) over large areas (several thousand square miles). The impact of a given tsunami on a coastline is a function of distance from the epicenter (usually inversely proportional to the square of the distance) and bathymetry near the shore or on the shelf. Wave energy is refracted towards areas of shallow water.

Tsunamis are detected by the Seismic Sea-Wave Warning System at the Environmental Sciences Services Administration station in Honolulu. Warnings are relayed first to the Oregon State Emergency Services Office and then to county and city personnel along the coast. A tsunami watch means that conditions conducive to the generation of a tsunami have occurred. A tsunami warning means that a tsunami has actually been observed. Warnings generally give 4 to 15 hours notice.

Impact: The Good Friday 1964 earthquake of Alaska registered 8.3 to 8.6 on the Richter Scale and satisfied all requirements for the generation of a large tsunami. Damage along the Oregon Coast amounted to $700,000 and 4 drownings. The wave had amplitudes of 4 to 14 feet above predicted tides along the Oregon Coast and an amplitude of 20 feet in Crescent City, where bathymetry favors amplification.

Study of tidal records at Crescent City show the Good Friday tsunami to be a 1 percent tsunami (1 chance of occurrence every 100 years) for that area. Tsunamis generally are not produced by seismic activity in the eastern Pacific, owing to the nature of displacement (strike slip) and the only moderate magnitudes of the quakes (none greater than Richter 7 in 100 years). Tsunamis generated in the western Pacific generally have little effect on the Oregon coastline owing to the distance factor.

Combining the highest observed tsunami (14 feet) with the highest predicted tide (10 feet) and the highest observed storm surge (4 feet) one arrives at a reasonable figure for the maximum possible tsunami (28 feet or 24 feet above sea level). Actual runup varies with topography and is very poorly documented. In assessing potential impact, it is noteworthy that the Good Friday tsunami was superposed upon the high spring tides.

Damage to be expected from probable tsunamis includes flooding of tidelands and low-lying areas, destruction of moorings, damage to moored vessels, and drownings of people on beaches and other low-lying areas. This latter hazard is particularly significant with respect to coastal parks and areas suited to such beach activities as beachcombing and clamming.

Recommendations: The greatest threat of tsunamis is loss of life to individuals in low-lying areas such as that which occurred during the Good Friday tsunami. It is imperative, therefore, that local warning procedures be efficient and comprehensive. Provisions should be made for announcements on all radio stations and for patrol of all beach areas in the event of a tsunami warning.

Critical developments such as hospitals and cooling water intake systems for nuclear reactors should be located and designed to accommodate the combined effects of tsunamis and ocean flooding.

All other developments should probably be evaluated in terms of the safety and evacuation of personnel and the cost and threats to safety and convenience of society in general. Efforts should be mode to educate those desiring to develop in regions of possible tsunami damage. Reflection upon the annual hurricane losses in the Gulf Coastal region place tsunamis along the Oregon coast in the proper perspective of being real, but moderate threats with a low frequency of occurrence.

Earthquakes

General: The shaking of the earth's surface which accompanies the sudden release of energy along a fault at the surface or at depth is termed on earthquake. The location of faulting is termed the focus, and the geographic location directly above the focus on the earth's surface is termed the epicenter. No mapped faults along the Oregon coast are known to be active (see Bedrock Structure).

Most of the Oregon coast is categorized as a zone of minor potential damage for which quakes of Mercalli Intensity V-VI may occur. The stretch of coast between Bandon and Florence is categorized as a zone of potentially moderate damage for which quakes of Mercalli VII may occur. The assessment of earthquake potential is based on a statistical analysis of records of past earthquakes. Numerous quakes of Mercalli IV have been experienced along the Oregon coast especially in the Newport area. The 1949 Puget Sound quake (Mercalli X, Richter 7.1) was felt with a Mercalli Intensity of VI in Florence. A Mercalli Intensity VIII quake is recorded for Port Orford and Crescent City in 1873. The precise location and intensity of quakes experienced so long ago are difficult to document with absolute certainty.

Impact: Moderate quakes (Intensity VII) are accompanied by general alarm, the cracking of walls, and the falling of plaster in a wide variety of structures. Minor quakes (Intensity V-VI) are associated with swaying trees and the overturning of loose objects.

The effects of earthquakes vary locally with bedrock and soil conditions. The impact is greatest over thick sections of saturated unconsolidated ground such as that in estuaries, beneath dune land, and along river bottoms. The impact on solid bedrock is considerably less.

Recommendations: Large structures should be designed to withstand the predicted earthquake intensities. The standard designs of smaller structures, such as most homes, are probably sufficient to withstand most quakes along the Oregon coastline. Highly sensitive types of industrial developments may require special engineering. Investigations for nuclear reactors are conducted by the utilities and are overseen by the Nuclear and Thermal Energy Council (see <u>Bedrock Structure</u>).

GOVERNMENTAL AGENCIES

Numerous federal, state, and local agencies provide services, studies, and information pertinent to geologic hazards. They are listed below along with brief descriptions of their hazard-related functions. Consultation with these agencies, where appropriate, is recommended for proper and efficient planning.

Federal Agencies:

U. S. Department of Agriculture

Agricultural Stabilization and Conservation Service

1) conducts flood-plain and watershed studies placing emphasis on soils, erosion, sedimentation, and general hydrology pertaining to agriculture.

Forest Service

1) provides for proper forest management through regulations specified in contracts and timber sales.
2) conducts in-house soil and slope stability surveys on forest land to provide necessary information for proper land management.
3) conducts hydrologic investigations of forested watersheds.
4) conducts studies of erosion and sedimentation related to forest practices.

Soil Conservation Service

1) administers the watershed Protection and Flood Protection Act of 1954. This includes:
   a) partial or total funding for the construction of flood preventive structures,
   b) technical assistance and engineering services for flood prevention,

c) provisions for watershed protection, flood prevention, fish and wildlife enhancement, irrigation, recreation, drainage, and municipal water supply studies.

2) conducts flood-plain delineation studies .

3) provides technical assistance to Soil and Water Conservation Districts.

4) assists in river and canal reclamation.

U. S. Department of Defense

Army Corps of Engineers

1) conducts flood-plain delineation studies.

2) finances, constructs, and plans channel clearing and bank protection works.

3) repairs and restores flood-damaged flood-control works.

4) constructs jetties and seawalls.

5) regulates encroachment into navigable waters by requiring permits from all agencies and individuals placing or constructing erosion control works in navigable waters.

U. S. Department of the Interior

Geological Survey

1) conducts ground-water studies and accumulates ground-water data.

2) conducts hydrologic studies.

3) conducts flood-plain delineation studies.

Bureau of Land Management

1) provides for favorable streamflows through the issuance of permits, contracts and licenses.

Bureau of Reclamation

1) provides for the construction of bank-protective structures to protect Bureau structures or to mitigate adverse downstream effects of Bureau projects.

U. S. Department of Transportation

Federal Highway Administration

1) provides for emergency repair and reconstruction for highways on the Federal-Aid System.
2) provides funding for emergency repair and reconstruction of National Forest highways, forest development roads, trails, and parkways.

U. S. Department of Housing and Urban Development

1) administers the Flood Insurance Act of 1968 as amended 1969. This includes funding and overseeing flood-plain delineation studies and sponsoring mudslide studies. Goal of the act is to discourage development in unsuitable areas and to provide disaster insurance for developments in areas identified as suitable.

U. S. Office of Emergency Preparedness

1) provides funding for emergency repairs to public property including highways, sewers, bridges, culverts, and streambanks.

State Agencies

Oregon State Department of Emergency Services

1) relays tsunami warnings from the Seismic Sea-Wave Warning System (U. S. Coast and Geodetic Survey) to appropriate county and city

agencies and personnel.

Department of Environmental Quality

1) regulates the use of motor vehicle bodies to protect streambanks.

2) regulates the use of septic tanks.

3) regulates landfill operations.

Fish Commission

1) provides for clearing and snagging operations where fish passage is blocked.

Department of Forestry

1) provides assistance to private landowners participating in Rural Environmental Assistance Programs, Watershed Programs, or Resource Conservation and Development Programs.

2) regulates reforestation, forest use, road location and construction, and logging methods through the implementation of the Forest Practices Act of 1971.

3) manages state forests in a manner consistent with the goal of flood prevention through appropriate specifications in sale contracts, special-use permits, performance bonds, and public liability insurance policies.

Department of Geology and Mineral Industries

1) produces comprehensive regional bulletins dealing with geologic hazards including landslides, erosion, deposition, floods, tsunamis, earthquake potential, and adverse soil and bedrock conditions.

2) provides assistance to local planning bodies in formulating hazard-related planning documents and policies.

3) assists state agencies in formulating land-use policies.

4) educates the public regarding the significance of geologic processes as hazards.

5) produces regional geologic hazard inventories and bibliographies.

Nuclear and Thermal Energy Council

1) with proper council, regulates the location of nuclear power plants in a manner consistent with geologic conditions.

Oregon Coastal Conservation and Development Commission

1) formulates broad policies of land-use planning compatible with geologic conditions in the Oregon coastal zone.

2) provides funding for specific studies crucial to the definition of the geologic hazards in the Oregon coastal zone.

State Engineer's Office

1) assists in the implementation of the Watershed Protection Act of 1954.

2) inspects hydraulic structures including dams and dikes, and the sites, plans, and specifications for them.

3) defines ground-water basins.

Land Board

Division of State Lands

1) regulates fills and removals in submerged or submersible land.

2) regulates material removal or other private use of state-owned land.

State Soil and Water Conservation Commission

1) informs Soil and Water Conservation Districts and coordinates their actions.

2) acts as liaison between Federal agencies, state agencies, and Soil and Water Conservation Districts.

3) oversees Soil and Water Conservation Districts programs and policies.

Water Resources Board

1) provides general and technical assistance in methods of bank protection.

2) assists in obtaining revetment projects.

3) assists in the implementation of the National Flood Insurance Act of 1968.

4) coordinates activities of state agencies with respect to water-related projects.

Local and Miscellaneous Agencies

County and City Planning Departments

1) formulates policies, goals, zoning ordinances, and building codes consistent with the threats posed by geologic hazards.

Oregon State University Cooperative Extension Service

1) provides information and conducts demonstrations.

Soil and Water Conservation Districts

1) conducts soil and water conservation surveys.

2) sponsors, constructs, and operates soil and water conservation structures.

3) secures the cooperation of Federal, state, and local agencies in promoting soil and water conservation.

4) manages within their boundaries soil and water conservation projects of the Federal or state government as their agents.

5) regulates land use in the interest of soil and water conservation.

BIBLIOGRAPHY

ANNOTATED BIBLIOGRAPHY

The more significant references pertaining to geologic hazards along the Oregon Coast are listed in the annotated bibliography. Accompanying each entry near the left-hand margin is a Roman Numeral signifying the general location of the study according to the following key*:

I. North Coast
II. Central Coast
III. Southern Coast
IV. Regional Study
V. Topical Investigation

*County is also indicated.

The landforms investigated in the reference are signified by a symbol along the centerline of the page according to the following key:

A. Beach
B. Dune Land
C. Sea Cliff
D. Lakes and Marshland
E. Estuary and Tidal Flats
F. Marine Terrace
G. Streams and Stream Terraces
H. Uplands
I. Islands
S. Several (three or more landforms)

Geologic Hazards and other pertinent topics discussed in the reference are signified by a symbol along the right-hand margin according to the following key:

1. Erosion
2. Sedimentation
3. Mass Wasting
4. Hydrology
5. Soil
6. Bedrock
7. Flooding
8. Earthquakes
9. General Geology
10. Resources

By effectively using the above keys the planner can quickly scan the bibliography for references on the subject of interest to him in a general geographic area of the coastal area of Oregon. Annotations following the bibliographic listing provide a more detailed account of the material in the specific references. Asterisks precede those references which are particularly useful from the standpoint of map coverage, scope of investigation, and depth of treatment.

North Coast

I, Tillamook S 9

Barr, E. M., 1939, Cape Lookout Trip: Geol. Soc. Oregon Country News Letter, v. 5, no. 14, p. 133-135.

> Discussion of the lithology and stratigraphy of the Oregon coastline with special attention given to Cape Lookout.

I, Tillamook & Clatsop S 1-10

*Beaulieu, John D., 1973, Environmental geology of inland Tillamook and Clatsop Counties, Oregon: Oregon Dept. of Geol. and Mineral Indus. Bull. 79, 65 p.

> Report is an evaluation of environmental geology (resources and hazards) of inland Clatsop and Tillamook counties; several maps.

I, Clatsop, Tillamook, Lincoln, Lane S 1

Byrne, John V., 1964, An erosional classification for the northern Oregon coast: Assoc. Am. Geographers Annals, v. 54, no. 3, p. 329-335.

> An erosional classification for the coast, subdividing the northern Oregon coast according to the geologic factors which control erosion and are largely responsible for the present shape of the coast line. Discusses factors affecting erosion, erosional classification (map and text), advantages of classification.

I, Clatsop, Tillamook S 1, 2, 3, 5, 6, 9

Byrne, John V., 1963, Coastal erosion, northern Oregon, in Essays in marine geology in honor of K. D. Emery,: Los Angeles, Calif., Univ. Southern California Press, p. 11-33.

> Study of marine erosional processes and depositional environments. Deposition of beach gravels, and sand dunes, estuarine and bay deposits. Erosion: structurally controlled landsliding, stratigraphically controlled, lithologically controlled, frequency and rate of erosion, and climatic and oceanographic factors.

I, Clatsop B 4, 9, 10

*Frank, F. J., 1970, Ground-water resources of the Clatsop Plains sand-dune area, Clatsop County, Oregon: U. S. Geol. Survey Water Supply Paper 1899-A, 41 p.

> A study of the ground-water potential of the Clatsop Plains sand-dune area:

water table configurations, fluctuation, source and recharge, movement and discharge, hydrologic properties of aquifer, chemical quality of the water.

I, Clatsop A,B 1, 2

*Cooper, William S., 1954, Sand-dune development and sea-level changes on the coast of northern Oregon [Abstr.]: Geol. Soc. America Bull., v. 65, no. 12, pt. 2, p. 1373.

Sand-dune development discussed in relation to geomorphic location and sea level fluctuation. Discussion of activity and stability characteristics of dunes.

I, Tillamook, Clatsop, Lincoln S 8

Dehlinger, Peter, and Joseph, W. B., Jr., 1962, The Portland earthquake of November 5, 1962: Ore Bin, v. 24, no. 11, p. 185-189.

Report contains information on Portland earthquake, (location, recordings, intensity-damage), and includes sketch map showing isoseismal ratings, (modified Mercalli) extending to northern and central Coast -- Tillamook, Clatsop, Lincoln Counties.

I, Tillamook A,B,C, 1,9

Laurence, T. Herbert, 1960, Cape Kiwanda sand dunes area field trip, February 21, 1960: Geol. Soc. Oregon Country Geol. News Letter, v. 26, no. 7, p. 48-51.

General geology of the Cape area -- history, stratigraphy; discussion of marine terraces and sand dunes.

I, Tillamook & Clatsop S 1, 2, 3, 9

Lund, Ernest H., 1972, Coastal landforms between Tillamook Bay and the Columbia River, Oregon: Ore. Bin, v. 34, no. 11, p. 173-194.

A discussion of the relation of coastal landforms to rock type -- classification of landforms and associated rock types.

I, Tillamook A,C,H 9

Mangum, Doris, 1967, Geology of Cape Lookout State Park, near Tillamook, Oregon: Ore. Bin, v. 29, no. 5, p. 85-109.

A review of the geographic setting and geology of the region, plus outlines of four trips, both hikes and drives, to points of interest -- park area and beach, Cape drive and hike, Netarts Bay and sandspit, and Cape Meares Loop.
Geologic Map

I, Clatsop S 9, 10

*Meyers, J. D., Leonard, R. T., and Granger, O. R., 1973, A plan for land and water use, Clatsop County, Oregon, Phase I: Clatsop County Planning Commission, 286 p.

> Description of the natural environment, the trends of existing development, and the attitudes and goals of residents. Sections on soils, hydrology, economy, land use.
>
> Small geologic maps 1" 5 mi.
> Soil associations
> Generalized slope areas
> Generalized hydrology

I, Clatsop, Tillamook, Lincoln,
Lane S 2, 3, 5, 6

North, William B. and Byrne, John V., 1965, Coastal landslides of northern Oregon: Ore Bin, v. 27, no. 11, p. 217-241.

> Data on the location and causes of active landslides, and determination of the frequency of landslides and rate of coastal retreat. Coastal physiography and general geology, landslide characteristics, distribution of landslides (general landslide distribution map, 1" 10 mi.). Summary of: landslide types of lithology, landslide frequency, rate of coastal retreat, and landslide prevention methods.

I, Clatsop, Tillamook G 4, 7, 10

*Oregon State Water Resources Board, 1961, North Coast Basin report: O.S.W.R.B., 142 p.

> Description of North Coast drainage basin. Includes physical and economic factors, water supply, water use and control, and stream development potential.

I, Clatsop C,H 3, 6

Schlicker, H. G., Corcoran, R. E., and Bowen, R. G., 1961, Geology of the Ecola State Park landslide area, Oregon: Ore Bin, v. 23, no. 9, p. 85-90.

> Documentation of 1961 Ecola State Park landslide. Includes description of bedrock geology, mechanism of landsliding, and photos of slide area. Reference is made to the active nature of the entire Oregon coastline.
>
> Generalized map of active and past
> slides in the park area

I, Tillamook and Clatsop S 1, 10

*Schlicker, H. G., Deacon, R. J., Beaulieu, J. D., and Olcott, G. W., 1972, Environmental geology of the coastal region of Tillamook and Clatsop Counties, Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 74, 164 p.

> A study to provide information to county officials, planners, developers, engineers, and private citizens concerning the geological conditions that exist in coastal Clatsop and Tillamook Counties. Provides information about potential problems in the area. Geography, geologic units, structural geology, economic mineral resources, engineering, characteristics of geologic units, geologic hazards, and a summary and recommendations.
>
> Engineering geologic maps
> Geologic hazard maps
> Slope maps

I, Tillamook, Clatsop 9
Columbia, Washington S

Warren, W. C., Norbisrath, Hans and Grivetti, R. M., 1945, Geology of northwestern Oregon, west of the Willamette River and north of latitude 45° 15': U. S. Geol. Survey Oil and Gas Invest. map OM42.

> Bedrock geology map (formational boundaries, structure, and topography) which includes cross-sections, fossil checklist and localities, and a stratigraphic column.
> Scale: 1 inch = 3 mi.

I, Clatsop and Columbia G 4, 10

Young, L. L., Colbert, J. L., Gaskill, D. L., and Piper, A. M., 1965, Waterpower resources in Nehalem River Basin, Oregon, with selections on geology of sites: U. S. Geol. Survey Water Supply Paper 1610-C, p. C1-C58.

> An estimate of the potential waterpower of the river and a discussion of possibilities for developing it.

Central Coast

II, Lincoln C,F 3, 6

Allen, J. E., and Lowry, W. D., 1943, The sea cliff landslide at Newport, Lincoln County, Oregon: Oregon Dept. Geol. and Mineral Indus. open-file report, 7 p.

> Investigation into the cause of the landslide at Jump-Off-Joe, Newport and the possibility of recurrence. Description of the slide, geologic history of the

area, lithology and stratigraphy, cause of slide potential for future recurrence. Includes recommendations as to prevention of slide damage.

II, Lincoln S 9

Baldwin, E. M., 1950, Pleistocene history of the Newport, Oregon region: Geol. Soc. Oregon Country News Letter, v. 16, no. 10, p. 77-81.

Description of Pleistocene events in the Newport area. Includes trocing of former drainages.

II, Lane S 9

Baldwin, E. M., 1956, Geologic mop of the lower Siuslaw River area, Oregon: U. S. Geol. Survey Oil and Gas Invest. Mop OM-186.

A shaded bedrock geologic map (formational boundaries, structure, and topography) which includes brief, written lithologic and stratigraphic-sequence information.
Scale: 1:62, 500

II, Lincoln, Benton S 9

Baldwin, E. M., 1955, Geology of the Marys Peak and Alsea quadrangles: U. S. Geol. Survey Oil and Gas Invest. Map OM-162.

A shaded geologic map (formational boundaries, structure, and topography) which includes a correlation chart and a descriptive text.
Scale: 1:62, 500

II, Lincoln E 1, 2

Byrne, John V., and Kulm, LaVerne D., 1967, Natural indicators of estuarine sediment movement: Am. Soc. Civil Engineers Proc., v. 93, paper 5220, Jour. Waterways and Harbors Div., no. WW 2, p. 181-194.

Detailed report on sedimentation processes in Yaquina Bay (Fluvial and marine) using natural indicators (i.e. grain size, mineralology).

II, Lane B 4, 10

*Hampton, E. R., 1963, Ground water in the coastal dune area near Florence, Oregon: U. S. Geol. Survey WSP 1539-K, 36 p.

Report deals with the ground-water potential of the coastal dune area near Florence. Shape and extent of ground-water body, source and recharge, movement and discharge, fluctuations of the water table, physical and hydraulic properties of dune sand, chemical quality and potential ground-water supply.

II, Lincoln G,H 1, 2, 4, 7

Harris, D. D., 1973, Hydrologic changes after clear-cut logging in a small Oregon coastal watershed: U. S. Geol. Survey, Jour. Research, v. 1, no. 4, p. 487-491.

A report of the effects of several methods of logging on watersheds in Alsea River basin. Evaluation of sediment yields, water temperatures, and runoff.

II, Lincoln G 1, 2, 4, 7

Harris, D. D., and Williams, R. C., 1971, Streamflow, sediment-transport, and water-temperature characteristics of three small watersheds in the Alsea river basin, Oregon: U. S. Geol. Survey Circ. 642, 21 p.

This report investigates the effects of specific logging, methods on three watersheds. Discusses stream flow, sediment transport, and water temperature of the three stations and precipitation on the watersheds.

II, Lincoln E 1, 2

*Kulm, L. D., and Byrne, J. V., 1966, Sedimentary response to hydrography in an Oregon estuary: Marine Geol., v. 4, no. 2, p. 85-118.

A study of the sediments in Yaquina Bay attempting to relate the sediments of the various estuarine environments to the hydrographic conditions within and adjacent to the bay. Nearshore and estuarine hydrography, sediments and processes of transportation and deposition.

II, Lincoln, Lane S 1, 2, 3, 6, 9

Lund, Ernest H., 1971, Coastal landforms between Florence and Yachats, Oregon: Ore Bin, v. 33, no. 2, p. 21-35.

II, Lincoln S 1, 2, 3, 6, 9

Lund, Ernest H., 1972, Coastal landforms between Yachats and Newport, Oregon: Ore Bin, v. 34, no. 5, p. 73-91.

II, Lincoln, Lane G 4, 10

*Oregon State Water Resources Board, 1965, Mid-Coast Basin report: O.S.W.R.B., 122 p.

Description of the mid-coast drainage basin. Includes physical and economic factors, water supply, water use, and stream-development potential.

II, Lincoln S 1, 10

*Schlicker, H. G., Deacon, R. J., Olcott, G. W., and Beaulieu, J. D., 1973, Environmental geology of Lincoln County, Oregon: Oregon Dept. Geol. Mineral Indus. Bull. 81, 171 p.

> Delineates broad areas where hazardous geologic conditions may exist for land use. Also includes description of stratigraphy, lithology, structure, economic mineral resources, ground-water resources, engineering characteristics of geologic units, geologic hazards, and recommendations.
>
> Environmental hazard maps
> Geologic maps

II, Lane S 9, 10

Smith, Warren D., Ruff, Lloyd L., 1938, The geology and mineral resources of Lane County Oregon: Oreg. Dept. Geol. Mineral Indus. Bull. 11, p. 65.

> Report discusses geologic economic and scenic resources of Lane County. Includes reports on metallic and non-metallic mine sites in the County (few are in coastal section). Report also includes description (location, size, history, etc.) of geologic scenic resources (i.e., dunes, Sea Lion Caves, coastal lakes).

II, Lincoln S 6, 9

Snavely, P. D., Jr., Rau, W. W., and Wagner, H. C., 1964a, Miocene stratigraphy of the Yaquina Bay area: Ore Bin, v. 26, no. 8, p. 133-151.

> Summarizes the lithologic characteristics and fauna of the Miocene sequence in the Yaquina Bay area of the Newport embayment.

II, Lincoln S 6, 9

Snavely, P. D., Jr., MacLeod, N. S., and Rau, W. W., 1969, Geology of the Newport area, Oregon: Ore Bin, v. 31, no. 2 and 3, p. 25-71.

> A guidebook designed to provide a general geologic description of the Newport area, and a field-trip route along which a representative sequence of Tertiary rock units can be best studied. I. Geologic history, stratigraphy, and lithology, and paleontology. II. Field trip guide, with geologic maps (2) (1" 1 mi.).

II, Lincoln S 9

Snavely, Parke D., Jr., and MacLeod, Norman S., 1971, Visitor's guide to the geology of the coastal area near Beverly Beach State Park, Oregon: Ore Bin, v. 33, no. 5, p. 85-105.

A description of the stratigraphy and geologic history of this scenic area.

II, Lincoln S 9

Snavely, P. D., Jr., MacLeod, N. S., and Wagner, H. C., 1972a, Preliminary bedrock geologic map of the Cape Foulweather and Euchre Mountain quadrangles, Oregon: U. S. Geol. Survey open-file map.

II, Lincoln S 9

Snavely, P. D., Jr., MacLeod, N. S., and Wagner, H. C., 1972b, Preliminary bedrock geologic map of the Waldport and Tidewater quadrangles, Oregon: U. S. Geol. Survey open-file map.

II, Lincoln S 9

Snavely, P. D., Jr., and Vokes, H. E., 1949, Geology of the coastal area between Cape Kiwanda and Cape Foulweather, Oregon: U. S. Geol. Survey Oil and Gas Invest. Map. OM-97.

> Colored bedrock geologic map (formational boundaries, structure, topography) which includes cross-sections, a fossil checklist, and a summary text of the area.

II, Lincoln S 9

Vokes, H. E., Norbisrath, H., and Snavely, P. D., 1949, Geology of the Newport-Waldport area, Lincoln County, Oregon: U. S. Geol. Survey Oil and Gas Invest. Map OM-88.

II, Lincoln, Benton G 4, 10

Young, L. L., Neal, D. W and Gaskill, D. L., 1966, Waterpower resources and reconnaissance geology of sites in the Alsea River Basin, Oregon: U. S. Geol. Survey Water Supply Paper 1610-D, p. D1-D45.

> An estimate of the potential hydro-power of the river and a discussion of the possibilities for developing it.

South Coast

III, Curry H 10

Allen, John Eliot, 1945, A vanadium-bearing black sand deposit of middle Mesozoic age, in central Curry County, Oregon [Abst.] Geol. Soc. Oreg. Country News Letter, v. 11, no. 4, p. 21.

III, Coos S 9, 10

Allen, J. E., and Baldwin, E. M., 1944, Geology and coal resources of the Coos Bay quadrangle: Oregon Dept. Geol. and Mineral Indus. Bull. 27, 153 p.

> Report is primarily a discussion of coal resources of the quadrangle. Deposits are outlined and discussed in relation to history, productivity, potential.

III, Douglas, Lane, Coos S 9

Baldwin, Ewart M., 1959, Eugene to Coos Bay via Reedsport, Field Trip No. 2, in Wilkinson, W. D., (ed.) Field Guidebook, June 1959: Oregon Dept. Geol. and Mineral Indus. Bull. no. 50, p. 33-41.

> Field trip guide. Includes generalized geologic map of the trip route as well as mileage guide to interesting geologic, cultural, historical points of interest.

III, Coos S 9

Baldwin, E. M., 1969, Geologic map of the Myrtle Point area, Coos County, Oregon: U. S. Geol. Survey Mineral Invest. Map MF-302.

> A colored, bedrock geologic map (formational boundaries, structure, and topography) with cross-sections and a brief written description of the map units and the economic geology.

III, Curry H 6, 9

Baldwin, E. M., 1965, Geology of the south end of the Oregon Coast Range Tertiary Basin: Northwest Sci., v. 39, no. 3, p. 93-103.

III, Coos S 6, 9

Baldwin, E. M., 1966, Some revisions of the geology of the Coos Bay area, Oregon: Ore Bin. v. 28, no. 11, p. 189-203.

> A progress report on geologic mapping in part of the Coos Bay area. Stratigraphy and structural geology (faulting, folding, and warping) are discussed.

III, Curry G,H 10

Baldwin, E. M., 1968, Geology of the Horse Sign Butte black sand deposit and vicinity, Curry County, Oregon: Ore Bin, v. 30, no. 3, p. 45-54.

> Describes the nature and extent of the black sand deposit and relates it to the geology of the area. Discusses geography and access, and provides a description of localities, origin and economic value of the sands.

III, Coos S 6, 7, 9, 10

*Baldwin, E. M., Beaulieu, John D., Ramp, L., Gray, J., Newton, V. C., and Mason, R. S., 1973, Geology and mineral resources of Coos County, Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 80, 82 p.

A description of the surficial deposits and bedrock units of the county, together with a geologic map. An outline and mine listing of the natural resources of the county (metallic minerals, industrial rocks and minerals, and fossil fuels).

Mineral resources map, 2" 10 mi.

III, Curry　　G　　1, 2, 10

Boggs, Sam, Jr., 1969, Distribution of heavy minerals in the Sixes River, Curry County, Oregon: Ore Bin, v. 31, no. 7, p. 133-150.

Information on the size and composition of the sand-size heavy minerals contained interstitially in the surface gravels of the Sixes River basin. Includes a discussion on the distribution of the heavy minerals.

III, Curry　　G　　1, 2, 10

Boggs, Sam, Jr., and Baldwin, Ewart M., 1970, Distribution of placer gold in the Sixes River, southwestern Oregon; a preliminary report: U. S. Geol. Surv. Bull. 1312-I, 27 p.

A study of the Sixes River, the factors controlling transportation and accumulation of gold in fluvial environments. Shows concentration and distribution of gold along the river and its tributaries.

III, Coos　　G,H　　6, 9, 10

Born, S. M., 1963, Geology of the southeastern third of the Powers quadrangle, Oregon: Univ. Oregon master's thesis, 4 p., unpub.

Master's thesis: Sections on stratigraphy structure, geologic history, and economic geology.

Colored geologic map, 1:31250

III, Coos　　S　　9, 10

Brown, Randall E., 1942, Some manganese deposits in the southern Oregon coastal region: Oreg. Dept. Geologyand Mineral Indus. Short Paper 9, 6p.

Report discusses four deposits in the South Oregon coastal region and describes the stratigraphy, lithology, mineralogy, and structure of the deposits, as well as recommendations as to development.

III, Coos　　B　　4, 9, 10

Brown, S. G., and Newcomb, R. C., 1956, Ground-water resources of the sand-dune area north of Coos Bay, Oregon: U. S. Geol. Survey, open-file report, 37 p.

Preliminary account of the ground-water potential for the coastal sand-dune area north of Coos Bay: fluctuation of the water table, aquifer properties, recharge, movement, discharge, chemical quality of the water, potential supply.

III, Coos B 4, 9, 10

*Brown, S. G., and Newcomb, R. C., 1963, Ground-water resources of the coastal sand-dune area north of Coos Bay, Oregon: U. S. Geol. Survey Water-Supply Paper 1619-D, 32 p.

Report of the hydrologic and geologic characteristics of the area as they relate to the extent and quality of the ground water and its reliability as fresh water source. Hydrology, ground-water body, aquifer tests, dune sand physical and hydrologic properties, recharge, quality, potential ground-water supply.

III, Douglas G 7

Corps of Engineers, 1966, Flood plain information, Douglas County, Oregon: U. S. Army Corps of Engineers, Portland district, Interim Report.

Report includes 32 sheets (1" 1,000') showing flood related information (area of inundation, river discharge, U.S.G.S. survey points) for Douglas County drainages.

III, Coos S 6, 9, 10

Diller, J. S., 1898b, The Coos Bay coal field, Oregon: U. S. Geol. Survey 19th Ann. Rpt., Pt. 3, p. 309-370.

An account of the geology of the coal field (formations, structure, analysis of the coals).

III, Coos S 6, 9, 10

Diller, J. S., and Pischel, M. A., 1911, Preliminary report on the Coos Bay coal field, Oregon: U. S. Geol. Survey Bull. 431, p. 190-228.

Report gives account of the separate coal basins of the Coos Bay coal field. Included are a discussion of the geology of the vicinity, the stratigraphy of coal beds, and analyses of coal from the various beds.

III, Curry S 6, 9

Dott, R. H., 1962, Geology of the Cape Blanco area, southwest Oregon: Ore Bin, v. 24, no. 8, p. 121-133.

Report primarily concerned with tectonic and structural history of Cape Blanco region; included is additional information on stratigraphy and lithology.

III, Curry S 6, 9, 10

*Dott, R. H., 1971, Geology of the southwestern Oregon Coast west of the 124th meridian: Oregon Dept. Geol. and Mineral Indus. Bull. 69, 63 p.

Comprehensive study of the geology of Curry County: tectonic setting, Mesozoic rocks of the central region, Cenozoic rocks, implications of the new global tectonics to southwest Oregon, and economic geology.

Geologic compilation map of western
Curry County 1:250,000.

III, Douglas S 10

Douglas County Planning Commission, 1968, The character of Douglas County: Douglas County Plan. Commission, 76 p.

Evaluation of resources of the county including description of soils, mineral resources, and water resources.

III, Coos H 9, 10

Duncan, D. C., 1953, Geology and coal deposits in part of the Coos Bay coal field, Oregon, U. S. Geol. Survey Bull. 982-B, 73p.

Geological investigations sample data, and estimated reserves in central part of the Coos County coal field..

III, Coos S 6, 9

Ehlen, Judi, 1967, Geology of state parks near Cape Arago, Coos County, Oregon: Ore Bin, v. 29, no. 4, p. 61-82.

Description of the plants, animals physiographic features, stratigraphy and geologic structure associated with the three State Parks, Sunset Bay, Shore Acres, and Cape Arago. Also contains a brief summary of the region's geologic history.

III, Coos G,H 6, 9

Fairchild, R. W., 1966, Geology of T. 29S., R. 11W., of the Sitkum and Coquille quadrangles, Oregon: Univ. Oregon master's thesis, 68 p., unpub.

Master's thesis: Sections on geography - culture - stratigraphy - structure, geologic history.

Geologic map 1:31, 680.

III, Coos, Curry A,F 9, 10

Griggs, A. B., 1945, Chromite-bearing sands of the southern part of the coast of Oregon: U. S. Geol. Survey Bull. 945-E, 150 p.

Report on chromite found in beach and marine terrace deposits of Coos and Curry counties. Discusses location, mineral occurrence, and percentage of ore. Also discusses general characteristics of beaches and marine terraces of the area.

Map - Distribution of terrace deposits
containing chromite. (3" 25 mi.).

III, Douglas S 6, 9, 10

Harms, J. E., 1957, Geology of the southeast corner of the Camas Valley quadrangle, Douglas County, Oregon: Oregon State Univ. master's thesis, 71 p., unpub.

Master's thesis: Contains sections on geography, stratigraphy, structural geology, physiography, historical and economic geology.

Colored geologic map 1:48000.

III, Coos G,H 6, 9

Hess, P. D., 1967, Geology of the northeast quarter of the Powers quadrangle, Coos County, Oregon: Univ. Oregon master's thesis, 91 p., unpub.

Investigation of the N. E. 1/4 of the Powers quadrangle; map, description and interpretation of the stratigraphy, lithology and structure of the area. Includes general discussion of the area's geologic history.

Geologic map 1:31, 250.

III, Curry S 6, 9

Howard, J. K., and Dott, R. H., Jr., 1961, Geology of the Cape Sebastian State Park and its regional relationships: Ore Bin, v. 23, no. 8, p. 75-81.

Geologic map of the coastal zone of the Gold Beach and Cape Ferrelo quadrangles.

III, Coos A,F 9, 10

Hundhausen, Robert J., 1947, Chromiferous sand deposits in the Coos Bay area, Coos County, Oregon: U. S. Bur. Mines Rpt. Inv. 4001, 13 p.

Report describes the results of investigations of chromiferons sand resources.

Location and accessibility, history and production, physical features, climate and vegetation, descriptions of the deposits, extent and lithology, description of the sands, and metallurgy.

III, Curry H 6, 9, 10

Hundhausen, R. J., McWilliams, J. R., and Banning, L. H., 1954, Preliminary investigation of the Red Flats nickel deposit, Curry County, Oregon: U. S. Bureau of Mines Rpt. Inv. 5072, 19 p.

A report of preliminary investigation of nickel deposits at Red Flats. Discusses locations, access, history, production, property and ownership, physical features, and climate. Description of the deposit includes stratigraphy, chemicals and mineralogical composition, drilling, sampling, metallurgical research, and recommendations.

III, Coos, Douglas G,H 3, 6, 9

Johannesen, N. P., 1972, The geology of the northeast quarter of the Bone Mountain quadrangle, Oregon: Univ. Oregon master's thesis, 98 p., unpub.

Master's thesis: stratigraphy, geomorphology, regional setting, structure. Includes discussion of mass wasting in the study area and Coast Range in general. Colored geologic map 1:31, 250.

III, Coos, Curry, Douglas G,H 6, 9, 10

Kent, R. C., 1972, The geology of the southeast quarter of the Bone Mountain quadrangle, Oregon: Portland State Univ. master's thesis, 132 p., unpub.

Master's thesis: geography, geomorphology, stratigraphy, and structure.

III, Coos S 6, 9, 10

Klohn, M. L., 1967, Geology of the north-central part of the Coos Bay quadrangle: Univ. Oregon master's thesis, 59 p., unpub.

Investigation to map the major formations. Includes a description of the lithology and extent of the stratigraphic units, and a determination of the depositional environment and geologic history of the north-central portion of the Coos Bay quadrangle. Geologic map 1:31, 250.

III, Curry S 3, 5, 6, 9

Koch, J. G., 1966, Late Mesozoic stratigraphy and tectonic history, Port Orford-

Gold Beach area. A short statement of recent developments, landslides, aluminum, and thick soils.

Geologic map 1" 2 mi.

III, Curry S 9

Koch, J. G., Kaiser, W. R., and Dott, R. H., Jr., 1961, Geology of the Humbug Mountain State Park area: Ore Bin, v. 23, no. 3, p. 23-30.

General geologic description of the area. Includes structure and delineation of marine terrace landforms.

III, Coos G,H 3, 6, 9

Krans, A.E.B., 1970, Geology of the northwest quarter of the Bone Mountain quadrangle, Oregon: Univ. Oregon master's thesis, 82 p., unpub.

Master's thesis: contains sections on geography, geomorphology, stratigraphy, structural geology, geologic history, and paleoecology.

III, Coos S 3, 6, 9, 10

Lent, R. L., 1969, Geology of the southern half of the Langlois quadrangle, Oregon: Univ. Oregon doctoral dissert., 189 p., unpub.

Doctoral dissertation with mapping, description, and evaluation of rocks in southern half of Langlois quad. Stratigraphy, petrographic study, sedimentary petrology, structure, geologic history, and economic geology (gold, chromite-manganese, road, and jetty material).

Geologic map 1: 31, 250.

III, Coos G,H 6, 9, 10

Lesher, C. E., 1914, The Eden Ridge coal field, Coos County, Oregon: U. S. Geol. Survey Bull. 541, Pt, 2, p. 399-418.

Report gives account of Eden Ridge coal field (locality, geology, stratigraphy, and an evaluation of the potential of the coal output).

III, Douglas S 9, 10

Libbey, F. W., 1951, Comments on the geology and mineral resources of Douglas County, Oregon: Ore Bin, v. 13, no. 2, p. 9-13.

Discussion of Douglas County geology in general terms. Includes material on coal deposits at Comstock near Umpqua River 17 miles west of Drain.

III, Coos G,H 6, 9, 10

Magoon, L. B., 1966, Geology of T. 28S., R. 11W. of the Coquille and Sitkum quadrangles, Oregon: Univ. Oregon master's thesis, 73 p., unpub.

> Master's thesis: Report on the stratigraphy, structure, geologic history, and economic geology (quarry rock) of T285, R11W, Coquille and Sitkum quadrangles.
> Geologic and topographic maps 1:30, 250.

III, Coos S 3, 6, 9

Nelson, E. B., 1966, The geology of the Fairview-McKinley area, central Coos County, Oregon: Univ. Oregon master's thesis, 59 p., unpub.

> An investigation of the stratigraphy, lithology, structure, depositional environments, and geologic history of the Fairview-McKinley area. Under geomophology, discussion of landslides and drainage of the area.
> Geologic map 1:31, 250.

III, Coos, Curry, Douglas S 9, 10

*Oregon Department of Geology and Mineral Industries, 1940, Oregon metal mines handbook (Coos, Curry, and Douglas Counties): Oregon Dept. Geol. and Mineral Indus. Bull. 14-C, vol. 1, 133p.

> Outline of mining areas or districts within the county with information (owner, location, equipment, workings, grade of ore, etc.) on individual mines. Covers both metallic and non-metallic deposits.

III, Curry G 4, 10

*Oregon State Water Resources Board, 1959, Rogue River Basin report: O.S.W.R.B., 440 p.

> Description of Rogue River drainage basin: includes economy of the basin, water problems (quantity, quality, flood, use conflicts), and basin potential.

III, Douglas G 4, 10

*Oregon State Water Resources Board, 1958, Umpqua River Basin report: O.S.W.R.B., 199 p.

> Description of Umpqua River Basin including economy of basin, water quality and quantity, control, future needs, and methods of development.

III, Douglas S 3, 6, 9, 10

Payton, C. C., 1961, The geology of the middle third of the Sutherlin quadrangle, Oregon: Univ. Oregon master's thesis, 81 p., unpub.

> Master's thesis: discusses general cultural, geographic, climatologic data, as well as stratigraphy, structure, geologic history, and economic geology (road rock, building stone, oil and gas, and ground-water).
>
> Colored geologic map 1:62, 500.

III, Coos, Douglas G,H 3, 6, 9, 10

Peterson, N. V., 1957, Geology of the southeast third of the Camas Valley quadrangle, Oregon: Univ. Oregon master's thesis, 89 p., unpub.

> Master's thesis: includes sections on climate, vegetation, culture geomorphology, stratigraphy, structure, geologic history, and economic geology (gold, limestone, road rock, oil and gas, groundwater).
>
> Includes colored geologic map 1:48, 000.

III, Douglas S 5

Pomerening, James A., and Simonson, Gerald H., 1970, Soil use interpretations for Douglas County, Oregon: Agricultural Experiment Station, Oregon State University, Spec. Rpt. 306, 50 p.

> Report is study of the soils (drainage, permeability, shrink-swell, texture, etc.) of Douglas County. Includes evaluation of soil suitabilities for agricultural and nonagricultural use.

III, Douglas S 6, 9, 10

*Ramp, Len, 1972, Geology and mineral resources of Douglas County, Oregon: Oregon Dept. of Geol. and Mineral Indus. Bull. 75, 106 p.

> All the pertinent information on the geology and mineral resources of Douglas County. Includes information on lithology, stratigraphy, mining activity, metallic mineral resources, industrial rocks and minerals, and fossil fuels.

III, Curry S 5

*U. S. Department of Agriculture, 1970, Soil Survey, Curryarea, Oregon: U.S.D.A. Soil Conservation Service, in cooperation with Oregon Agricultural Experiment Station.

> Description of soils (depth, horizons, engineering characteristics, chemical characteristics) in coastal Curry County. Includes maps showing soil series

distribution.

Soils map 1:20, 000.

III, Coos, Curry G,H 6, 9, 10

Utterback, W. C., 1973, The geology and mineral deposits of Eden Valley-Saddle Peaks and vicinity, southeastern Coos and northeastern Curry Counties, Oregon: Univ. Oregon master's thesis, unpub., 81 p.

Master's thesis: includes sections on stratigraphy, structure, geomorphology, and economic geology.

Colored geologic map 1:12, 000.

III, Coos S 9

Weaver, C. E., 1945, Stratigraphy and paleontology of the Tertiary formations at Coos Bay, Oregon: Univ. Wash. Publ. in Geol. v. 6, no. 2, p. 31-62.

Report on the structural, lithologic, and stratigraphic details of the Arago, Bastendorff, Tunnel Point, and Empire formations in the seacliff sections. Locates many fossil collections stratigraphically.

Geologic maps.

III, Curry I 9, 10

Weissenborn, A. E., and Snavely, Parke D., Jr., 1968, Summary report on the geology and mineral resources of the Oregon Islands National Wildlife Refuge, Oregon: U. S. Geol. Survey Bull. 1260-G, p. G1-G4.

A summary of the geology and mineral resources as compiled from available geologic information.

III, Josephine S 9

Wells, F. G., and Walker, G. G., 1953, Geologic map of the Galice quadrangle, Oregon: U. S. Geol. Survey Quadrangle Map in coop. with Oregon Dept. of Geol. and Mineral Indus.

Colored, bedrock, geologic map (formational boundries, structure, and topography) which includes cross-sections, a stratigraphic column, and an attached text. In addition, placer and lode deposits are listed in the explanation and shown on the map.

Scale: 1:62, 500.

III, Coos, Curry S 9

Wells, Francis G., 1955, Preliminary geologic map of southwestern Oregon west of meridian 122° west, and south of parallel 43° north: U. S. Geol. Survey Mineral Inv. Field Studies Map MF 38. Scale about 1 in. to 4 mi.

III, Coos, Curry S 9

Wells, F. G., Hotz, P. E., and Cater, F. W., Jr., 1949, Preliminary description of the geology of the Kerby quadrangle, Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 40, 23 p.

> Report on the geology (stratigraphy, structure, lithology) of the quadrangle; includes a color geologic map 1:96, 000.

III, Coos G,H 9, 10

Williams, Ira A., 1914, The occurrence of coal in Squaw Creek Basin, Coos County, Oregon: Ore. Bur. Mines Min. Res., v. 1, no. 1, p. 28-48.

> First report on Squaw Creek coal field. Very basic preliminary material, but covers geography, vegetation, rock type, structure, and the occurrence, character, and extent of the coal field.

Regional Study

IV H 10

Allen, J. E., 1941, Chromite deposits in Oregon: Oregon Dept. Geol. and Mineral Indus. Bull 9, rev. ed.

> Report gives account of chromite mining industry (methods and economics, etc.) and includes evaluations of several mines in Coos and Curry Counties including consideration of location, mineral occurrence, workings, grade of ore, and production.

IV S 10

Allen, J. E., and Mason, R. S., 1949, Brick and tile industry in Oregon: Oregon Dept. Geol. and Mineral Indus. Short Paper 19, 28 p.

> Report on existing (1949) brick and tile works in Oregon and on several potential clay sites. Five localities (1 plant and 4 potential sites). Report contains brief information on history, geology, equipment, location, owner, and production.

IV S 10

Andrews, David A., Hendricks, T. A., and Huddle, John W., 1947, The coal fields of Arizona, California, Idaho, Nevada, and Oregon: U. S. Bur. Mines Tech. Paper 696, p. 1-12.

Report gives the production, distribution, and use of the coals of Oregon, along with relationship of mine samples to commercial shipments. Results of various sample tests as to quality of coal.

IV S 9

Baldwin, E. M., 1964, Geology of Oregon: Eugene, University of Oregon Cooperative Book Store, 164 p.

Book contains a section on the coastal portion, geology (history and formations); an extremely brief statement of more modern erosion factors and landsliding.

IV G,H 1, 2, 3

Balster, Clifford A., and Parsons, Roger B., 1968, Sediment transportation on steep terrain, Oregon Coast Range: Northwest Sci., v. 42, no. 2, p. 62-70.

A study of sediment transport on steep terrain goes into the mechanics of sediment transport, landslides, earthflows, slump, soilfall, and rockfall.

IV S 8

Barazangi, M., and Dorman, J., 1969, World seismicity maps compiled from ESSA, Coast and Geodetic Survey, Epicentral Data: Seismol. Soc. Amer. Bull., v. 59, no. 1, p. 369-380.

World seismicity maps compiled for the interval Jan. 1, 1961 to Dec. 31, 1967. A map of all data with maps showing events deeper and shallower than 100 mi.

IV S 10

Brooks, H. C., 1963, Quicksilver in Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 55, 223 p.

Report includes description and evaluation of 3 quicksilver producing areas within the coastal region (1 quarry, 2 placer mines, and includes description of geology and production).

IV S 9, 10

Brooks, H. C., 1971, Quicksilver deposits in Oregon: Oregon Dept. Geol. and Mineral Indus., Misc. Paper 15.

Map of quicksilver deposits, (2" = 35 mi). Report on back of map. Summarizes briefly the salient geologic features of the principal quicksilver-bearing areas and large mines in Oregon.

IV S 10

Brooks, H. C., and Ramp, Len, 1968, Gold and silver in Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 61, 337 p.

> Discussion of gold and silver localities along with information on the history, occurrence, methods, and economics of gold mining in Oregon.

IV B 10

Carter, G. J., Harris, H. M., and Strandberg, K. G., 1964, Beneficiation studies of the Oregon coastal dune sands for use as glass sand: U. S. Bureau of Mines Rpt. Inv. 6484, 21 p.

> A study of the coastal dune sands as a potential supply of glass sand. Physical and chemical properties, magnetic separation, electrostatic separation, flotation, acid leaching, glass melting tests, sampling, geomorphology of the dunes are discussed.
>
> A map of the Dune Sand areas including aerial maps showing active beach and dune sand.

IV S 10

Clifton, H. E., and Mason, R. S., 1969, Black sands, in Oregon Dept. Geol. and Mineral Indus. Bull. 64, in coop. with U. S. Geol. Survey, p. 102-107.

> A general account of the "black sands" along the Oregon Coast including a definition of black sands, a description of deposit locations, and an account of the history of black sand mining in Oregon.

IV B 9

*Cooper, W. S., 1958, Coastal sand dunes of Oregon and Washington: Geol. Soc. America Memoir 72, 169 p.

> Environment of the dunes, dune forms and processes, dunes of the Oregon coast divided into several regions. Discussion of the northern Oregon dunes, Coos Bay dune sheet, southern Oregon dunes, and the Clatsop Plains. (Map of the Coast with coastal features, dune localities, exposures of ancient eolian sediments).

IV S 8

Couch, R. W., and Lowell, R. P., 1971, Earthquakes and seismic energy release in Oregon: Ore Bin, v. 33, no. 4, p. 61-84.

Discussion of earthquake activity in various subdivisions of Oregon. Includes map of epicenters in Oregon. 1841-1970.

IV S 3, 9

Delano, Leonard, 1963, An aerial reconnaissance of geomorphology of Oregon and Washington coasts: Geol. Soc. Oregon Country Geol. News Letter, v. 29, no. 3, p. 22-23.

General overview of the geomorphology of the Oregon Coast. A lecture with use of slides of the coastal areas.

IV A,B,E 1, 2, 3

Dicken, Samuel N., Johannessen, Carl L., and Hanneson, Bill, 1961, Some recent physical changes of the Oregon coast - Final report: Eugene, Oregon Univ., Dept. Geography, 151 p.

Report is concerned with some of the physical changes of the Oregon Coast occurring since settlement (changes of the beaches and the immediate backshore, of the active dunes near the shore, and of the estuaries). Describes the processes that bring about changes, and classifies types of coastlines.

IV A,G 2

Kulm, L. D., Scheidegger, K. F., Byrne, J. V., and Spigai, J. J., 1968, A preliminary investigation of the heavy mineral suites of the coastal rivers and beaches of Oregon and northern California: Ore Bin, v. 30, no. 9, p. 165-180.

Determination of the nature of the heavy mineral suites in each of the major coastal drainages of Oregon and northern California that contribute sediment to the ocean. Includes detection of real and temporal variations in sediment sources and determination of the predominant direction of littoral drift or sediment transport along the coast.

IV S 9, 10

Mason, R. S., 1969, Coal, in Mineral and water resources of Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 64, in coop. with U. S. Geol. Survey, p. 272-278.

A general compilation of information on the various coal fields in the state, with an expanded report on the Coos Bay Field. Information includes geologic, historical, economic data, as well as remaining resource evaluation.

IV S 10

Mason, R. S., and Erwin, Margaret I., 1955, Coal resources in Oregon: U. S. Geol. Survey Circ. 362, 7 p.

> A summary of the available information on the occurrence, composition, and distribution in the state. A map indicates locations of coalfields and areas underlain by coal-bearing rocks. (7 localities and 2 coalfields within the coastal zone) 1" 25 mi.

IV S 4, 5, 7, 10

Oregon State Water Resources Board, 1969, Oregon's long-range requirements for water, Umpqua drainage basin: U. S. Dept. of Agr. and O.S.U. Agr. Exp. Station, in coop. with Oregon State Water Resources Board, Appendix I-16, 77 p.

> Report contains soil maps and supporting soil descriptions, interpretations, and acreage figures for the Umpqua Basin. Includes information on flooding, high ground-water, and other soil or water related hazards, as well as soil suitability information.

IV S 5, 7, 10

*Oregon State Water Resources Board, 1969, Oregon's long-range requirements for water, north, mid-, and south coast; Drainage basins: U. S. Dept. of Agr. and Ore. State Univ. Agr. Exp. Station, in coop. with Ore. State Water Resources Board, 83 p. Appendix I-1, 17, 18.

> Report consists of general soil maps and supporting soil descriptions, interpretations, and acreage figures for the lowlands and marine terrace areas of the north, mid-, and south Coast drainage basins. Includes information on extent of flooding, high ground water, and other soil or water related hazards, as well as soil suitability information.
>
> Maps included 1:158, 400

IV S 7, 8

Pottulo, J. G., Burt, W. V., and Burdwell, G. B., 1968, Tsunami on the Oregon Coast from an earthquake near Japan: Ore Bin, v. 30, no. 9, p. 182-184.

> Brief information on the effects of the tsunami, and deals with the tsunami warning system and future prediction of tsunami effects.

IV S 1, 4, 10

Phillips, K. M., 1969, Ground-water resources, in Mineral and water resources of

Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 64 in coop. with U. S. Geol. Survey, p. 325-340.

> Report contains general information on coastal water conditions. Includes surface-water flow rates, water-quality data, ground-water availability, and stream sediment-load ratings.

IV G 7

Reckendorf, F. F., 1973, Techniques for identifying flood plains in Oregon: Oregon State Univ. doctoral dissert., 344 p.

> Evaluation of seven methods for delineating flood plains - geomorphic, soils, botanical, hydrological, hydrologic, hydraulic, historical, and combination method. Identification mapping of chronological sequences of natural flood plains.

IV A,B 1, 2, 9

Schatz, C. E., Curl, H., Jr., and Burt, W. V., 1964, Tsunamis on the Oregon Coast: Ore Bin, v. 26, no. 12, p. 231-232.

> Report dealing with the occurrences of tsunamis, their dissipation, and areas of vulnerability.

IV A,B 1, 2, 9

Twenhofel, William H., 1946, Mineralogical and physical composition of the sand of Oregon Coast from Coos Bay to the mouth of the Columbia River: Ore. Dept. Geology and Mineral Indus. Bull. 30, 54 p.

> Report is primarily classification of sands (size, shape, mineralogy, etc.) but includes information on beach sediment transport, erosion, deposition and derivation.

IV S 1

*U. S. Army, Corps of Engineers, 1971a, National shoreline study, inventory report, Columbia-North Pacific Region, Washington, and Oregon: Portland, North Pacific Division, U. S. Army, Corps of Engineers, 80 p.

> Overall comprehensive assessment of the beach and shore erosion problems; an inventory of the physical characteristics, historical changes, ownership, and use of the coastal shoreline of Oregon, including major bays and estuaries. Historical changes relate to erosion produced by wave and tidal phenomena.

IV S 5

U. S. Department of Agriculture, 1971-72, 73, Oregon soil interpretations: U.S.D.A. Soil Conservation Service OR-1 series.

The OR-1 series consists of individual data sheets for the various soil series in Oregon (as defined by the S.C.S.). Information contained on these sheets includes significant engineering properties, soil limitations, and suitabilities for a variety of agricultural and non-agricultural uses.

IV G 4, 7

Waananen, A. O., Harris, D. D., and Williams, R. C., 1970, Floods of Dec. 1964 and Jan. 1965 in the far western states. Part 2. Streamflow and sediment data: U. S. Geol. Survey Water Supply Paper 1866-B, p. 771-839.

Basic records of stage, discharge, sediment concentration, and load.

IV G 1, 2, 4, 7

Waananen, A. O., Harris, D. D., and Williams, R. C., 1971, Floods of Dec. 1964 and Jan. 1965 in the far western states. Part I. Description: U. S. Geol. Survey Water Supply Paper 1866-A, 265 p.

The general description of storms and floods of December 1964 and January 1965, discussion of the floods and flood damage in the several basins, and summaries of flood damage, maximum stages and discharges, and maximum sediment concentrations and loads.

IV S 9

Wells, F. G., and Peck, D. L., 1961, Geologic map of Oregon west of the 121st meridian: U. S. Geol. Survey Misc. Geol. Invest. Map I-325, in coop. with Oregon Dept. Geol. and Mineral Indus.

Colored geologic map showing formational boundaries, structure and cross-sections. Included on the map are various stratigraphic columns, a list of sources of geologic data and an index map of the various 15' and 30' topographic maps available for western Oregon.

Scale: 1:500, 000

Topical Investigation

V B 1, 2, 9

Bascom, Willard, 1964, Waves and beaches, the dynamics of the ocean surface: Garden City, N. Y., Anchor Books.

> Description of beach forms and processes including beach formations littoral current, beach erosion, and erosion prevention methods.

V G,H 1, 2, 3, 5

Gray, Donald H., 1970, Effects of forest clear-cutting on the stability of natural slopes: Ass. Eng. Geol. Bull., v. 7, no. 1-2, p. 45-66.

> The evidence for a cause-and-effect relationship between deforestation and massive soil movement is reviewed. A theoretical stability analysis is outlined for the prediction of the stability of a forested slope and assessment of probable consequences of denudation on a more rational basis. A field study in Oregon obtained quantitative data on soil moisture stress and soil mantle creep before and after clear-cutting.

V A,B 4, 10

*Hampton, E. R., 1961, Ground water from coastal dune and beach sands, Art. 85,: U. S. Geol. Survey Prof. Paper 424-B, p. B204-B206.

> Report deals with ground-water levels from coastal dunes and beach sands; general composition and size of sands are considered.

V A,B,C 1, 2

Shepard, F. P., and Wanless, H. R., 1971, Our changing coastline: New York, McGraw-Hill, 579 p.

> Book describes types of coastlines (world-wide) and has short section on documented alterations of various coastal configurations. Covers Oregon Coast and includes alterations due to man (i.e. jetties, groins, etc., as well as alterations due to natural processes).

V A 1, 2

Sonu, C. J., 1973, Three-dimensional beach changes: Jour. Geology, v. 81, no. 1, p. 42-64.

Discussion of distinctive modes of beach change due to the 3-D structure and the tendency for migration of rhythmic topography. Pertinent to the understanding and rigorous evaluation of coastal erosion.

V H 3

Terzaghi, Karl, 1950, Mechanism of landslides, <u>in</u> Paige, S., chm., Application of geology to engineering practice: Geol. Soc. America, Berkey Volume, p. 83-123, illus.

Varieties of slope movements and processes leading to landslides (dynamics of landslides, and landslide problems). Field work done in England.

V A,B,E 1, 2, 7

U. S. Army, Corps of Engineers, 1971, Shore Protection guidelines: Washington, D. C., U. S. Army, Corps of Engineers, 59 p.

Guidelines for general use of suitable and economical methods of shore protection. Goes into the general nature of the shoreline problem, natural beach protection, dunes, barrier beaches, lagoons and inlets, origin and movement of beach sands, today's beach conditions, forces of the sea, behavior of beaches, man-made effects on the shore, regional protective practices, and conservation of sand.

V S 10

U. S. Geological Survey, 1971, A procedure for evaluating environmental impact: U. S. Geological Survey Circ. 645, 13 p.

Description of proposed methodology of evaluating potential environmental impact from various developments. Includes flow chart and evaluation matrix.

V A,B 1

Webber, Bert, 1973, What happened at Bayocean - is Salishan next?: Fairfield, Wn., Ye Galleon Press, 40 p.

V S 3

White, W. A., and Bremser, S. M., 1966, Effects of a soap, a detergent, and a water softener on the plasticity of earth materials: Ill. State Geol. Survey Environ. Geol. Notes no. 12, 15 p., August.

A study to show the changes induced in clay minerals by soap, detergent, and water softener, and in the stability characteristics of unconsolidated rock materials. To evaluate the effects of changes on the physical environment and the influence on slope stability of earth materials beneath and around man-made structures.

GENERAL BIBLIOGRAPHY

In this bibliography are listed references (pertaining to geology, geologic hazards, and resources) which may be of use at some stage of the planning process, but which are not of the more widespread utility of references cited in the annotated bibliography. The general bibliography is subdivided into the following five categories according to location or nature of treatment:

North coast
Central coast
Southern coast
Regional
Topical

Numbers in the right-hand margin signify the emphasis of the article according to the following key:

1. General geology or geomorphology
2. Structure
3. Earthquakes and tsunamis
4. Hydrology and floods
5. Resources
6. Soils
7. Planning or environmental information

North Coast

1
Baldwin, E. M., 1952, The geology of Saddle Mountain, Clatsop County, Oregon: Geol. Soc. of Oregon Country News Letter, v. 18, no. 4, p. 29-30.

1
Baldwin, E. M., and Roberts, A. E., 1952, Geology of the Spirit Mountain quadrangle, northwestern Oregon: U. S. Geol. Survey Oil and Gas Invest. Map OM-129.

6
Bowlsby, C. C., and Swanson, R. C., 1964, Soil survey of Tillamook area, Oregon: U. S. Dept. Agriculture, Soil Conservation Service, in coop. with Oregon Agri. Exp. Sta., Series 1957, no. 18.

2
Bromery, R. W., and Snavely, P. D., Jr., 1964, Geologic interpretation of reconnaissance gravity and aeromagnetic surveys in northwest Oregon: U. S. Geol. Survey Bull. 1181-N.

7
Bureau of Governmental Research and Service, [1970] (not dated), A comprehensive plan for Tillamook County: Tillamook County Planning Commission, with technical assistance from Univ. of Oregon, Bureau of Governmental Research and Service, 45 p.

1, 7
Dole, H. M., 1954, The Astoria landslide: Ore Bin, v. 16, no. 1, p. 1-2.

1
Howell, Paul W., 1962, How the Nehalem River lost its head: Geol. Soc. Oregon Country Geol. News Letter, v. 28, no. 11, p. 73-74.

1, 7
Kidby, Harold A. and Oliver, John G., 1966, Erosion and accretion along Clatsop Spit, *in* Coastal engineering, Santa Barbara SpecialtyConf., 1965,: New York, American Society of Civil Engineers, p. 647-671.

1
Layfield, Robert, 1936o, Saddle Mountain: Geol. Soc. of Oregon Country News Letter, v. 2, no. 13, p. 7.

1
Layfield, Robert, 1936b, Geology of Saddle Mountain State Park and vicinity: Geol. Soc. of Oregon Country News Letter, v. 12, no. 24, p. 4-10.

1
Lowry, W. D., and Baldwin, E. M., 1952, Late Cenozoic geology of the lower

Columbia River valley, Oregon and Washington: Geol. Soc. America Bull., v. 63, no. 1, p. 1-24.

5

Oregon Department of Geology and Mineral Industries, 1951, Oregon Metal Mines Handbook - northwestern Oregon: Ore. Dept. Geol. and Mineral Indus. Bull. 14-D, 166 p.

7

Pacific Northwest River Basins Commission, 1968, Plan of study, Supplement 1 - Columbia-North Pacific region comprehensive framework study: Vancouver, Wn., Columbia-North Pacific Technical Staff, Pacific N. W. River Basins Commission, C-NP 15, 170 p.

7

Tillamook County Staff, OSU Extension Service, 1968, Tillamook County's 1968 long-range planning report.

6

Torgerson, E. F., McWilliams, James, and McMurphy, C. J., 1949, Soil survey, Astoria area: U. S. Dept. of Agriculture in coop. with Oregon Agri. Exp. Sta., Series 1938, no. 20.

4

U. S. Department of Agriculture, 1966, North Coast drainage basin, Oregon: U. S. Dept. of Agriculture, Oregon River Basin Survey in coop. with Oregon State Water Resources Board, 148 p.

4

U. S. Army, Corps of Engineers, 1971, Flooded areas, Wilson, Trask, and Tillamook Rivers, Tillamook County, Oregon: Portland, Oregon, Portland District, U. S. Army Corps of Engineers.

4

U. S. Army, Corps of Engineers, 1972, Flooded areos, Nehalem Bay, Nehalem River, and North Fork Nehalem River, Tillamook Co.: Portland, Oregon, Portland District, U. S. Army Corps of Engineers, March 1972, map.

5

Woolfe, L. C., 1964, A progress report on material source investigations for Tillamook County: Oregon State Highway Department, Soils and Geology Section, 183 p., open-file report.

5

Woolfe, L. C., 1965, Materials investigations for the Burnside-Big Creek unit, Astoria-Big Creek section, Lower Columbia River Highway, Clatsop County: Oregon State

Highway Dept., Soils and Geology Section, 33 p., open-file report.

Central Coast

5

Allen, V. T., Loofbourow, J. S., Jr., and Nichols, R. L., 1951, The Hobart Butte high-alumina clay deposit, Lane County, Oregon: U. S. Geol. Survey Circ. 143, 11 p.

7

Bureau of Governmental Research and Service, 1969, Preliminary land use plan for the Yaquino Bay area: University of Oregon, 97p.

1

Byrne, John V., 1962, Geomorphology of the continental terrace off the central coast of Oregon: Ore Bin, v. 24, no. 5, p. 65-74.

1

Byrne, John V. andKulm, LaVerne D., 1968, Natural indicators of estuarine sediment movement - closure (to discussion of paper 5220, 1967,): Am. Soc. Civil Engineers Proc., v. 94, paper 5924, Jour. Waterways and Harbors Div. no. WW 2, p. 242-244.

1

Gaskill, David L., 1961, Geology, *in* Waterpower resources of the Wilson River Basin, Oregon: U. S. Geol. Survey Water Supply Paper 1329-B, p. 42-48.

1

Norton, Hiram A. Jr., 1971, Reconnaissance geology of Seal Rock State Park, Oregon: Compass, v. 48, no. 3, p. 115-117.

5

Oregon Department of Geology and Mineral Industries, 1953, Tonnage estimates, Coos Bay fields: unpublished tabulation for Oregon Development Commission, Oct. 1953.

5

Snavely, P. D., and Wagner, H. C., 1961, Differentiated gabbroic sills and associated alkalic rocks in the central part of the Oregon Coast Range, Oregon: U. S. Geol. Survey Prof. Paper 424-D, p. 156-161.

1

Snavely, P. D., Wagner, H. C., and MacLeod, N. S., 1969, Geology of western Oregon north of the Klamath Mountains: Oregon Dept. Geol. and Mineral Indus. Bull. 64, in coop. with U. S. Geol. Survey, p. 32-46.

4
U. S. Army, Corps of Engineers, 1971c, Special flood plain information, Siletz River, Lincoln County, Oregon: Portland, Oregon, Portland District, U. S. Army Corps of Engineers, November.

4
U. S. Army, Corps of Engineers, 1972, Special flood plain information, Siletz and Alsea Rivers: U. S. Army, Corps of Engineers, 5 p., 5 plates.

4, 5
U. S. Department of Agriculture, Soil Conservation Service, 1964, Middle coast drainage basin, Oregon; water and related land resources: U. S. Dept. of Agri. in coop. with Oregon State Water Resources Board, 135 p.

4
U. S. Department of Agriculture, 1972, The flood plain hazard and flood plain lands of Lincoln County, Oregon: Portland, Oregon, USDA Soil Conservation Service, September 1970 (maps revised 1972).

4
U. S. Geological Survey, 1969, Map of flood-prone areas, Toledo quadrangle: U. S. Geol. Survey preliminary map.

Southern Coast

5
Appling, R. N., Jr., 1955 A reconnaissance of nickel deposits of southwest Oregon and northwest California: in coop. with California-Oregon Power Co. and U. S. Bureau of Mines, unpub.

5
Appling, R. N. Jr., 1958, Manganese deposits of southwestern Oregon: U. S. Bureau of Mines Rpt. Inv. 5369, 56 p.

1
Baldwin, E. M., and Hess, P. D., 1971, Geology of the Powers quadrangle, Oregon: Oregon Dept. Geol. and Mineral Indus. Map GMS-5.

5
Bartley, Ronald C., 1972, An unusual gold occurrence from Douglas County: Ore Bin, v. 34, no. 3, p. 52-53.

3
Berg, J. W. , Jr., and Baker, C. D., 1962, Oregon earthquakes, 1841 through 1958: Ore Bin, v. 24, no. 9, p. 143-149.

5
Bowman, Kenneth Charles Jr., 1972, Sedimentation, economic enrichment and evaluation of heavy mineral concentrations on the southern Oregon continental margin: Doctoral dissertation, Oregon State Univ., unpub.

1
Butler, Gurdon M., and Mitchell, G. J., 1916, Preliminary survey of the geology and mineral resources of Curry County, Oregon: Oreg. Bur. Mines, Min. Res. Oregon, v. 2, no. 2, 134 p.

1
Byrne, John V., Geomorphology of the Oregon continental terrace south of Coos Bay: Ore Vin, v. 25, p. 147-157.

1, 5
Chace, F. M., Cumberlidge, J. T., Cameron, W. L., and Van Nort, S. D., 1969, Applied geology at the Nickel Mountain mine, Riddle, Oregon, *in* Econ. Geol., v. 64, no. 1.

1
Champ, J. G., Jr., 1969, Geology of the northern part of the Dixonville quadrangle, Oregon: Univ. Oregon master's thesis, 86 p., unpub.

5
Clifton, H. E., 1968, Gold distribution in surface sediments on the continental shelf off southern Oregon: a preliminary report: U. S. Geol. Survey Circ. 587, 6 p.

1
Clifton, H. E., Hunter, R. E., and Phillips, R. L., 1971, Depositional systems on the high-energy coast of southern Oregon, [Abstr]: Natl. Coastal Shallow Water Res. Conf., Abstr., no. 2, p. 43.

1, 5
Cumberlidge, J. T., and Chace, F. M., 1968, Geology of the Nickel Mountain mine, Riddle, Oregon, *in* Ore Deposits in the United States, 1933-1967: New York, American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Graton-Sales vol.

1
Cummings, Jon C., 1962, Recent estuarine and marine sediments, Coos Bay area, Oregon [Abstr.]: Am. Assoc. Petroleum Geologists Bull., v. 46, no. 2, p. 263.

1
Diller, J. S., 1898, Description of the Roseburg quadrangle, Oregon: U. S. Geol. Survey Geol. Atlas, Roseburg Folio no. 49, 4 p.

1
Diller, J. S., 1901, Coos Bay folio, Oregon: U. S. Geol. Survey Geol. Atlas of the U. S., Folio no. 73.

1
Diller, J. S., 1903, Port Orford folio, Oregon: U. S. Geol. Survey Geol. Atlas of U. S., Folio no. 89.

5
Diller, J. S., and Kay, G. F., 1909, Mineral resources of the Grants Pass quadrangle and bordering districts: U. S. Geol. Survey Bull. 380-A, p. 48-79.

5
Diller, J. S., 1914, Mineral resources of southwestern Oregon: U. S. Geol. Survey Bull. 546, 147 p.

1
Ehlen, J., 1969, The geology of a coastal strip near Bandon, Coos County, Oregon: Univ. of Oregon master's thesis, 83 p., unpub.

1
Gale, Hoyt S., 1921, Priceite, the borate mineral in Curry County, Oregon: Min. and Sci. Press, v. 123, no. 26, p. 895-898.

1, 2
Greene, H. Gary, Janda, R J., and Blom, K., 1971, Seismic refraction data bearing on the late Quaternary history of the lower Sixes River Valley, southwest Oregon [Abstr.]: Geol. Soc. Amer., Abstr., v. 3, no. 6, p. 384.

1
Hicks, D. L., 1964, Geology of the southwest quarter of the Roseburg quadrangle, Oregon: Univ. Oregon master's thesis, 97 p., unpub.

1
Hixson, H. C., 1965, Geology of the southwest quarter of the Dixonville quadrangle, Douglas County, Oregon: Univ. Oregon master's thesis, 97 p., unpub.

5
Hoffman, Charles S., 1970, Priceite in Curry County: Ore Bin, v. 32, no. 2, p. 34-35.

5
Horner, R. R., 1918, Notes on the black sands deposits of southern Oregon and

northern California: U. S. Bureau Mines Tech. Paper 196, 42 p.

5
Hotz, P. E., 1964, Nickeliferous laterites in southwestern Oregon and northwestern California: Econ. Geology, v. 59, no. 3, p. 355-396.

1, 5
Hotz, Preston E., 1971, Geology of lode gold districts in the Klamath Mountains, California and Oregon: U. S. Geol. Surv. Bull., no. 1290, 91 p.

1
Hunter, Ralph E., Clifton, H. Edward, and Phillips, R. Lawrence, 1970, Geology of the stacks and reefs off the southern Oregon coast: Ore Bin, v. 32, no. 10, p. 185-201.

4, 5
Jones, Benjamin E., and Stearns, Harold T., 1930, Waterpower resources of the Umpqua River and its tributaries, Oregon: U. S. Geol. Survey Water Supply Paper 636, p. 221-320.

5
Kay, G. F., 1907, Nickel deposits of Nickel Mountain, Oregon: U. S. Geol. Survey Bull. 315-C, p. 120-127.

5
Kellogg, A. E., 1922, Platinum in the quartz veins of southwest Oregon: Eng. Mining Jour. Press, v. 113, no. 23, p. 1000.

5
Kellogg, A. E., 1927, Origin of manganese in southwest Oregon: Mining Jour., Phoenix, Ariz., v. 11, no. 13, p. 7, 13.

5
Kellogg, A. E., 1928, Auriferous gravels of southwest Oregon: Mining Jour., Phoenix, Ariz., v. 11, no. 20, p. 3-6, 54-55.

5
Kellogg, A. E., 1928, Origin of copper in southwestern Oregon: Mining Jour., Phoenix, Ariz., v. 12, no. 2, p. 9-10.

1, 7
Kidby, H. A., and Price, C. D., 1965, Umpqua jetty surveillance program, Portland District, U. S. Army, Corps of Engineers: paper presented at October 1965 meeting, Amer. Soc. Civil Engineers.

5
Kulm, L. D., Heinrichs, D. F., Buehrig, R. M., and Chambers, D. M., 1968,

Evidence for possible placer accumulations on the southern Oregon continental shelf: Ore Bin, v. 30, no. 5, p. 81-104.

1
Lissner, Fredrick G., 1971, Sources of littoral-zone sands in the vicinity of Gold Beach (Curry County), Oregon: Master's thesis, Univ. of Oregon, unpub.

4
McEvilly, T. V., 1968, Seafloor mechanics north of Cape Mendocino, California: Nature, v. 220, no. 5170, p. 901-903.

5
Ore Bin, 1953, The Nickel Mountain project: Ore Bin, v. 15, no. 10, p. 59-65.

5
Oregon Dept. of Geology and Mineral Industries, 1943, Oregon Metal Mines Handbook, C. Southwestern Oregon, vol. 2-sec. 2-Jackson County: Oregon Dept. Geol. Mineral Indus. Bull. 14, 208 p.

5
Oregon Department of Geology and Mineral Industries, 1954, Oregon's gold placers: Ore. Dept. Geol. Mineral Indus. Misc. Paper no. 5, 14 p.

5
Oregon Department of Geology and Mineral Industries, 1970, Nickel-bearing stream sediments from southwestern Oregon: Ore Bin, v. 32, no. 12, p. 221-230.

5
Pecora, W. T., and Hobbs, [illegible]. W., 1942, Nickel deposit near Riddle, Douglas County, Oregon: U. S. Geol. Survey Bull 931-I, p. 205-226.

1
Phillips, R. L., 1968, Structure and stratigraphy of the northern quarter of the Langlois quadrangle, Oregon: Univ. Oregon master's thesis, 91 p., unpub.

1, 5
Ramp, Len, 1957, Geology of the lower Illinois River Chromite district (Oregon): Ore Bin, v. 19, p. 29-34.

5
Ramp, Len, 1957, Nature and origin of the southwestern Oregon chromite deposits: Mining Eng., v. 9, no. 8, p. 894-897.

5
Ramp, Len, 1960, Gold placer mining in southwestern Oregon: Ore Bin, v. 22, no. 8, p. 75-79.

5
Ramp, Len, 1960, The Quartz Mountain silica deposit, Oregon: Ore Bin, v. 22, no. 11, p. 109-114.

5
Ramp, Len, 1961, Chromite in southwestern Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 52, 169 p.

5
Rockwell, Cleveland, 1902, The Coos Bay coal fields, Oregon: Eng. Mining Jour., v. 73, p. 238-240, 270-271.

1
Rud, J. O., 1971, Geology of the southwest quarter of the Bone Mountain quadrangle, Oregon: Univ. Oregon master's thesis, 73 p., unpub.

5
Shenon, Philip J., 1933, Copper deposits in the Squaw Creek and Silver Peak districts and at the Almeda mine, southwestern Oregon, with notes on the Pennell and Farmer and Banfield prospects: U. S. Geol. Survey Circ. 2, 35 p.

1
Trigger, J. K., 1966, Geology of the south-central part of the Sitkum quadrangle, Coos County, Oregon: Univ. Oregon master's thesis, 79 p., unpub.

5
Twenhofel, W. H., 1943, Origin of the black sands of the coast of southwestern Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 24, 25 p.

5
Twenhofel, William H., 1946, Beach and river sands of the coastal region of southwest Oregon with particular reference to black sands: Am. Jour. Sci., v. 244, no. 2, p. 114-139, Pt. 2, Minerals of the sands, no. 3, p. 200-214.

4
U. S. Army, Corps of Engineers, 1966, Postflood report, December 1964, January 1965 flood: U. S. Army, Corps of Engineers, 237 p.

5
Wayland, Russell G., 1964, The correlation of coal beds in Squaw Basin and part of Eden Ridge, T. 33S., R. 11W., W.M., southwestern Oregon: U. S. Geol. Survey open-file report, 27 p.

1
Wells, F. G., 1956, Geology of the Medford quadrangle, Oregon-California: U. S. Geol. Survey Map GQ-89.

5
Wells, F. G., and Waters, A. C., 1934, Quicksilver deposits of southwestern Oregon: U. S. Geol. Survey Bull. 850, 58 p.

Regional

1
Anderson, Henry W., Wallis, James R., 1965, Some interpretations of sediment sources and causes, Pacific Coast Basins in Oregon and California, in Federal Inter-Agency Sedimentation Conf., Jackson, Miss., 1963, Proc. Symposium 1 - Land erosion and control: U. S. Dept. Agriculture Misc. Pub. 970, p. 22-30.

6
Balster, C. A., and Parsons, R. B., 1966, A soil-geomorphic study in the Oregon Coast Range: Corvallis, Oregon State Univ. Agr. Exp. Sta. Tech. Bull. 89, 30 p.

4
Bartholomew, W. S., and Debow, Robert, 1970, Ground-water levels 1967-1968: Oregon State Engineer, Ground Water Rpt. 15, 122 p.

1
Beaulieu, J. D., 1971, Geologic formations of western Oregon, west of longitude 121° 30': Oregon Dept. Geol. and Mineral Indus. Bull. 70, 72 p.

3
Berg, J. W., Jr., and Baker, C. D., 1963, Oregon earthquakes, 1841 through 1958: Seismol. Soc. Amer. Bull., v. 53, p. 95-108.

5
Blake, William P., 1855, Observations on the extent of the gold region of California and Oregon: Amer. Jour. Sci., v. 20, p. 72-85.

5
Braislon, D. B., Hastings, D. D., and Snavely, P. D., Jr., 1971, Petroleum potential of western Oregon and Washington and adjacent continental margin: Amer. Assoc. Petrol. Geologists Memoir 15.

4
Bureau of Governmental Research and Service, 1971, Flood-plain management for Oregon cities and counties: University of Oregon and Oregon State Water Resources Board, 22 p.

3
Byerly, Perry, 1940, Seismicity of the northern Pacific Coast of the United States: Geol. Soc. America Bull., v. 51, no. 2, p. 255-260.

5
Byrne, John V., 1962, Here's a look at offshore Oregon: Oil and Gas Jour., v. 60, no. 30, p. 116-119.

5
Clark, F. W., 1888, Some nickel ores from Oregon: Am. Jour. Sci., 3d ser., v. 35, p. 483-488.

3
Couch, Richard W., and Pietrafesa, Leonard J., 1968, Earthquakes off the Oregon coast, January 1968 to Sept. 1968: Ore Bin, v. 30, no. 10, p. 205-212.

5
Day, D. T., and Richards, R. H., 1906, Useful minerals in the black sands of the Pacific Slope: U. S. Geol. Survey, Mineral Resources of the U. S. for 1905, p. 1175-1246.

7
Day, L. B., 1972, Difficulties ahead for Oregon regarding estuary regulations, control, and protection: Ann. Tech. Conf. Estuaries Pac. Northwest, Proc., no. 2, p. 50-54.

5
Diller, J. S., Westgate, L. G., and Pardee, J. T., 1921, Deposits of chromite in California, Oregon, Washington, and Montana: U. S. Geol. Survey Bull. 725-A.

4
Emmer, R. E., and Muckleston, K. W., 1971, A compilation of flood abatement projects in Oregon: Oregon State Univ. Water Resources Research Inst., WRRI-11, 112 p.

6, 7
Franklin, Jerry F., and Dyrness, C. T., 1969, Vegetation of Oregon and Washington: U.S.D.A. Forest Service Research Paper, P.N.W. - 80, 216 p.

5
Harris, Henry M., Strandberg, Karle G., Kelly, Hal J., 1962, Resources for making expanded aggregate in western Washington and Oregon: U. S. Bur. Mines Rpt.

5
Harrison and Eaton [firm], 1920, Report on investigation of oil and gas possibilities of western Oregon: Oregon Bur. Mines and Geology, Mineral Res. Oregon, v. 3, no. 1, p. 3-37.

5
Hotz, P. E., and Ramp, Len, 1969, Nickel, in Mineral and water resources of Oregon:

Oregon Dept. Geol. and Mineral Indus. Bull. 64, in coop. with U. S. Geol. Survey, p. 163-167.

5

Kauffman, A. J., and Baber, K. D., 1956, Potential of heavy-mineral-bearing alluvial deposits in the Pacific Northwest: U. S. Bureau of Mines Inf. Circ. 7767, 36 p.

5

Kauffman, A. J., and Holt, D. C., 1965, Zircon: a review with emphasis on West Coast resources and markets: U. S. Bureau of Mines IC 8286, p. 21-25.

5

Kelly, Hal J., 1959, Major clay basins of Western Washington, and Oregon [Abstr.]: Mining Eng. v. 11, no. 1, p. 39.

5

Libbey, Fay W., 1938, Progress report on Coos Bay coal field: Oregon Dept. Geology and Mineral Indus. Bull. 2, 14 p.

5

Libbey, F. W., 1957, Limestone resources of the Pacific Northwest: Raw Materials Survey Res. Rpt., no. 9, p. 37-69.

5

Mason, R. S., 1969, Gem stones, in Mineral and Water Resources of Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 64, in coop. with U. S. Geol. Survey, p. 211.

3

McMahus, Dean A., 1964, Major bathymetric features near the coast of Oregon, Washington, and Vancouver Island: Northwest Sci., v. 38, no. 3, p. 65-82.

5

Newton, V. C., Jr., 1965, Oil and gas exploration in Oregon: Oregon Dept. Geol. and Mineral Indus. Misc. Paper 6, 41 p.

5

Ore Bin, 1971, Green Diamond abrasives: Ore Bin, v. 33, no. 9, p. 182.

7

Oregon Dept. of Planning and Development, 1964, Oregon comprehensive statewide planning study, summary report, 115 p.

7

Oregon State Engineer, 1962, Rules and regulations of the State Engineer prescribing general standards for the construction and maintenance of water wells in Oregon: p. 33-50.

4
Oregon State Water Resources Board, 1963, South Coast Basin: Salem, 125 p.

4
Oregon State Water Resources Board, 1970a, The flood plain and flood damage reduction: Salem, 8 p.

4
Oregon State Water Resources Board, 1970b, A flood plain management program for local planners: Salesm, 7 p.

5
Parsons, R. B., Bolster, C. A., 1966, Morphology and genesis of six "Red Hill" soils in the Oregon Coast Range: Soil Sci. Soc. America Proc., v. 30, no. 1, p. 90-93.

5
Peterson, N. V., and Mason, R. S., 1958, Limestone occurrences in western Oregon: Ore Bin, v. 20, no. 4, p. 33-39.

5
Smith, George O., 1902, The coal fields of the Pacific Coast: U. S. Geol. Survey Ann. Rpt., v. 22, Pt. 3, p. 473-512.

3
Smith, W. D., 1919, Earthquakes in Oregon: Seismol. Soc. America Bull., v. 9, no. 3, p. 59-71.

5
Smith, W. D., 1924, Petroleum possibilities of western Oregon: Econ. Geology, v. 19, no. 5, August.

5
Spreen, C. A., 1939, A history of placer gold mining in Oregon, 1850-1870: Univ. Oregon master's thesis, unpub.

1
Steere, Margaret L., 1954, Fossil localities of Lincoln County beaches, Oregon: Ore Bin, v. 16, no. 4, p. 21-26.

7
Ternyik, W. B., 1972, Pacific Northwest coastal zone management as it relates to estuary protection: Ann. Tech. Conf. Estuaries Pacific Northwest, Proc., no. 2, p. 109-111.

5
Thayer, T. P., and Romp, Len, 1969, Chromite, in Mineral and Water Resources of

Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 64, in coop. with U. S. Geol. Survey, p. 108-116.

5
Vhay, J. S., 1966, Olivine, serpentine, and asbestos, in Mineral and Water Resources of Washington: Washington Div. of Mines and Geology, reprint 9, p. 231-235.

5
Washbourne, Chester W., 1904, Beach gold and its source: Oregon Univ. Bull.,NSL, no. 4, p. 19-20.

Topical

1
American Commission of Stratigraphic Nomenclature, 1970, Code of stratigraphic terms: Tulsa, Okla., Am. Assoc. of Petroleum Geologists Bull. 73.

1
Bullard, W. E., 1962, Estimating sediment production in a large watershed [with French abstract]: Internat. Assoc. Sci. Hydrology Bull., v. 7, no. 3, p. 40-45.

4
Center for Urban Studies, 1967, Introduction to flood proofing: Chicago, University of Chicago, 61 p.

1
Clifton, H. E., Hunter, R. ., and Phillips, R. L., 1972, Depositional models from a high-energy coast [Abstr..: Am. Assoc. Petroleum Geologists Bull., v. 56, no. 3, p. 609.

3
Coast and Geodetic Survey, 1965, Tsunami! The story of the seismic sea-wave warning system: U. S. Dept. of Commerce, 46 p.

5
Cooper, J. D., 1970, Clays: in Mineral facts and problems: U. S. Bur. Mines Bull. 650, p. 923-938.

3
Eppley, R. A., 1965, Earthquake history of the United States, Part 1. Stronger earthquakes of the United States: U. S. Coast and Geodetic Survey Bull. 41-1, 48 p.

7
Flown, P. T., Fisher, W. L., and Brown, L. F., Jr., 1969, Environmental geology and theCoast rationale for land-use planning: National Association of Geology Teachers Symposium, Atlantic City, N. J., Nov. 10, 1969, 4 p., unpub. [Authors at Univ. of Texas, Austin].

1
Gary, Margaret, McAfee, Robert, Jr., and Wolf, C. L., 1972, Glossary of geology: Washington, D. C., Amer. Geological Inst., 857 p.

4, 7
Goddard, J. E., 1971, Flood plain management must be ecologically and economically sound: Civil Engineering, Sept.

1
Holmes, Arthur, 1965, Principles of physical geology: Ronald Press Co., 1288 p.

1
Legget, Robert F., 1973, Cities and Geology: McGraw-Hill Book Co., New York, 624 p.

1
Levorsen, A. I., 1954, Geology of petroleum: San Francisco, W. H. Freeman Co.

1
McHarg, I. L., 1969, Design with Nature: Garden City, N. Y., Natural History Press.

1
Miller, J. N., 1968, The way of the waves: Readers Digest, Aug. 1968 [condensed from Beacon Magazine, Hawaii].

1
Shepard, F. P., 1948, Submarine geology: New York, Harper and Brothers, 348 p.

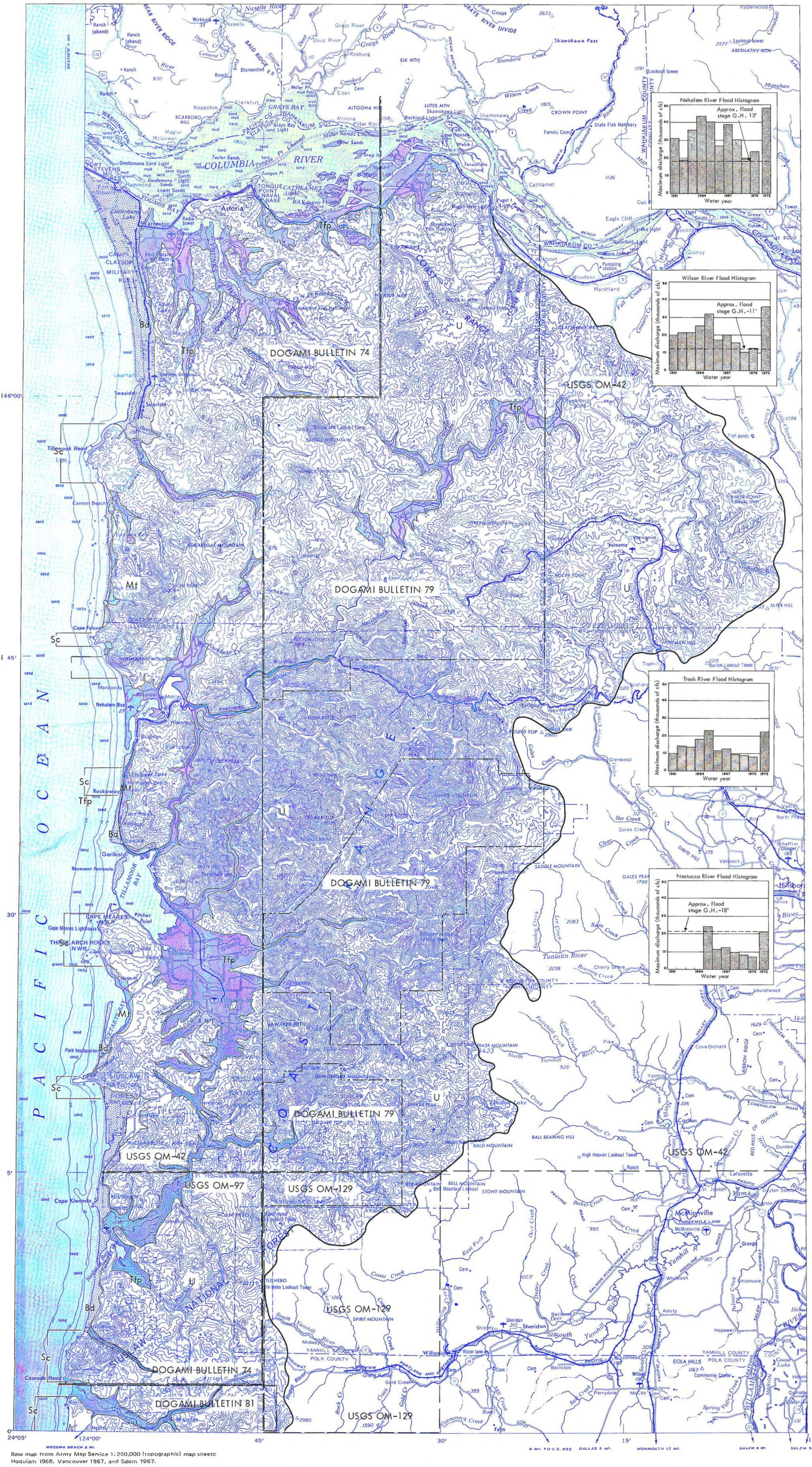
1
Slosson, J. E., 1969, The role of engineering geology in urban planning, in The Governor's Conference on Environmental Geology: Colo. Geol. Survey Spec. Publ. no. 1, p. 8-15.

6
Spangler, M. G., 1951, Soil Engineering: Scranton, Pa., International Textbook Co., 458 p.

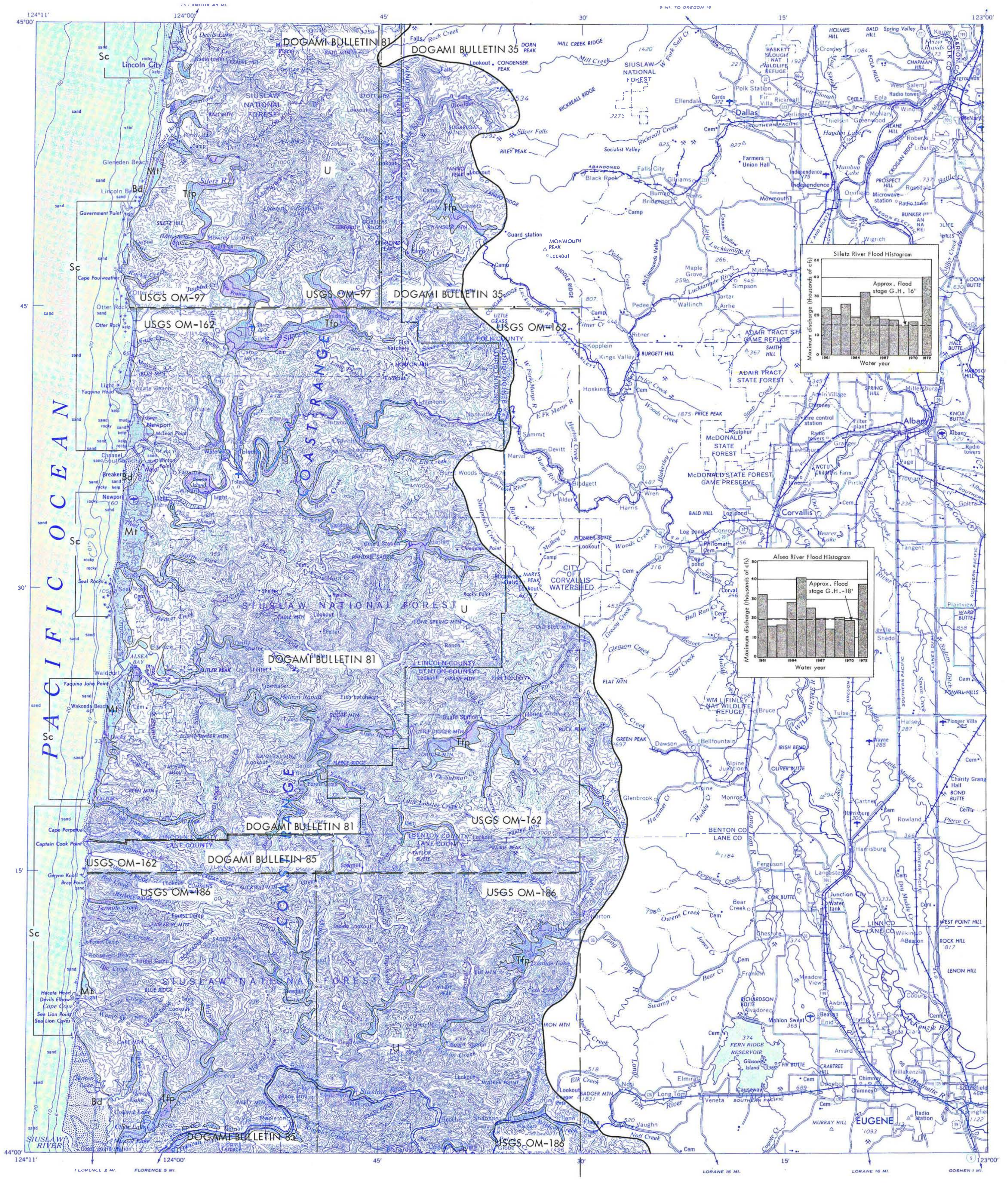
4, 7
U. S. Dept. of Housing and Urban Development, 1972, The National Flood Insurance Program: 10 p.

4, 7
U. S. Geological Survey, 1967, Flood information for flood-planning: U. S. Geol. Survey Circ. 539, 10 p.

4, 7
U. S. Water Resources Council, 1971, Regulation of flood hazard areas to reduce flood losses: Washington, D. C., U. S. Water Resources Council, v. 1.

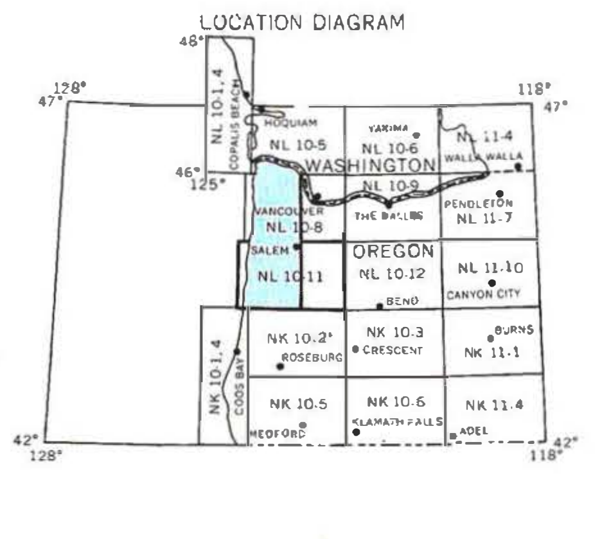


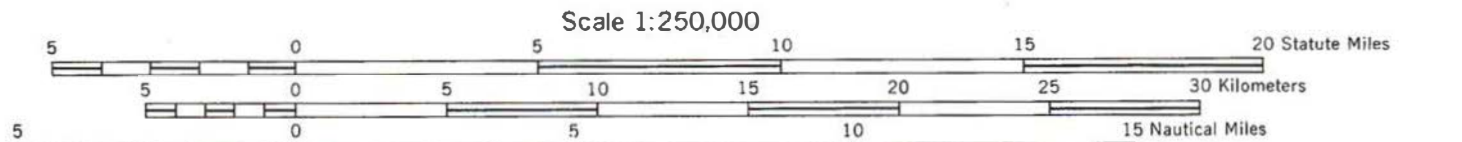
Base map from Army Map Service 1:250,000 (topographic) map sheets: Hoquiam 1968, Vancouver 1967, and Salem 1967.



STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
R. E. CORCORAN, STATE GEOLOGIST

GEOLOGIC HAZARDS INDEX MAP
of the
OREGON COASTAL ZONE
(NORTH HALF)





CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

1965 MAGNETIC DECLINATION FROM TRUE NORTH FOR THIS SHEET VARIES FROM 21° (370 MILS) EASTERLY FOR THE CENTER OF THE WEST EDGE TO 20° (360 MILS) EASTERLY FOR THE CENTER OF THE EAST EDGE.

EXPLANATION

Landforms

Each landform has associated with it certain potential geologic hazards (see Table 1 in text). To assure accuracy in determining landform, this map should be used in conjunction with other appropriate references (see Selected Maps, Bibliography) and on-site inspection if necessary.

U	Uplands — *gently to steeply sloping terrain inland from beaches, dunes, and marine terraces and upslope from estuaries, tidelands, stream terraces, and flood plains.*
Sc	Sea cliff — *steeply sloping oceanside faces of headlands and terraces.*
Tfp	Stream terraces and flood plain — *elevated and valley bottom deposits of alluvium along rivers and streams.*
🟦	Water — *ocean, estuaries, rivers, lakes, streams, and marsh (see flood hydrographs).*
Mt	Marine terraces — *flat, elevated, wave-cut platforms along the coastline brought to their present position by regional uplift (some low terraces may owe their origin to former higher sea level).*
Bd	Beaches and dune land — *gently sloping, unconsolidated, wave-transported material and dunes of unconsolidated windblown sand (does not include dunes on large marine terraces).*

List of Selected Maps

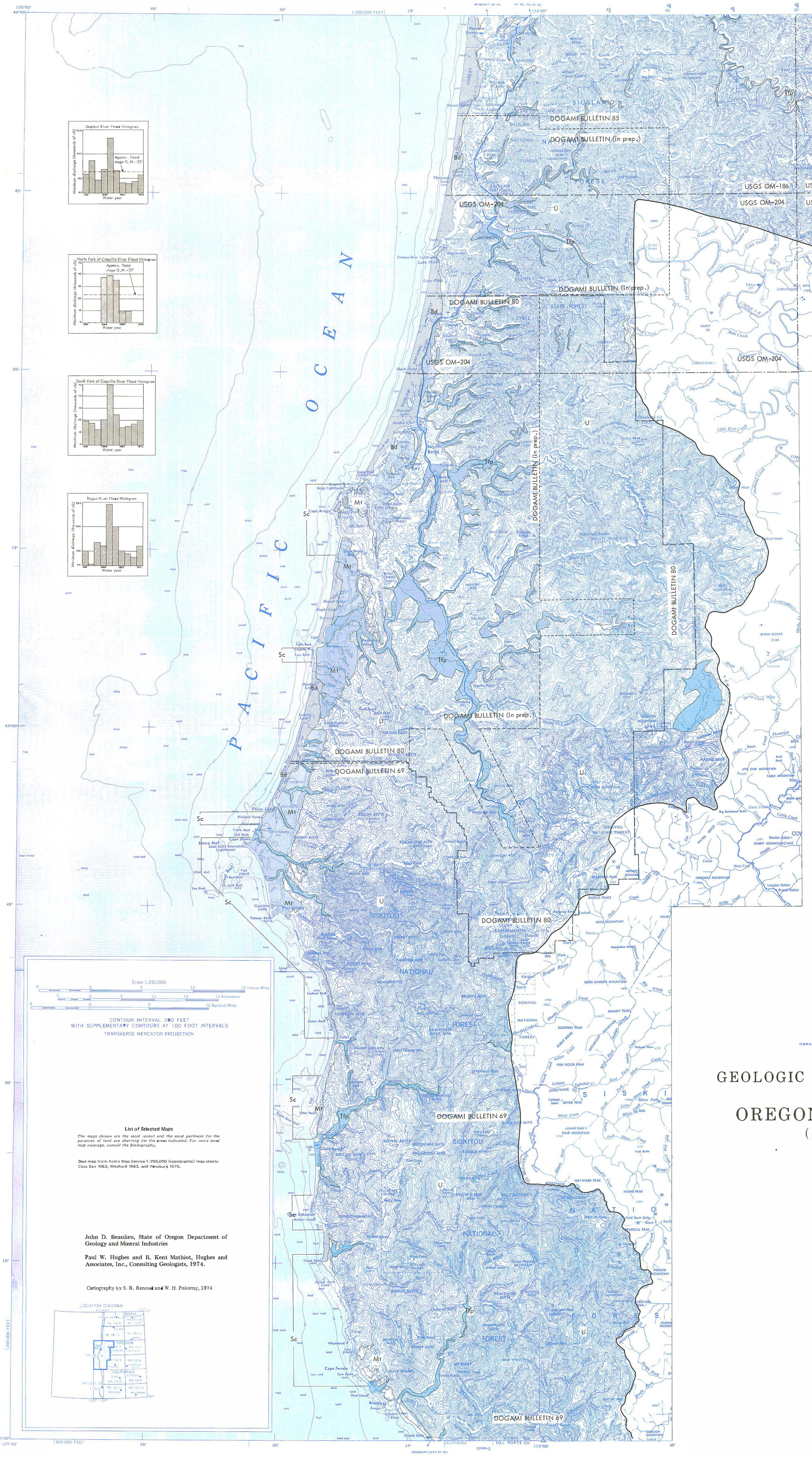
The maps shown are the most recent and the most pertinent for the purposes of land use planning for the areas indicated. For more local map coverage, consult the Bibliography.

John D. Beaulieu, State of Oregon Department of Geology and Mineral Industries

Paul W. Hughes and R. Kent Mathiot, Hughes and Associates, Inc., Consulting Geologists, 1974.

Cartography by W. H. Pokorny and S. R. Renoud, 1974

MP-17



CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

List of Selected Maps

The maps shown are the most recent and the most pertinent for the purposes of land use planning for the areas indicated. For more local map coverage, consult the Bibliography.

Base map from Army Map Service 1:250,000 (topographic) map sheets: Coos Bay 1962, Medford 1963, and Roseburg 1970.

John D. Beaulieu, State of Oregon Department of Geology and Mineral Industries

Paul W. Hughes and R. Kent Mathiot, Hughes and Associates, Inc., Consulting Geologists, 1974.

Cartography by S. R. Renoud and W. H. Pokorny, 1974

EXPLANATION

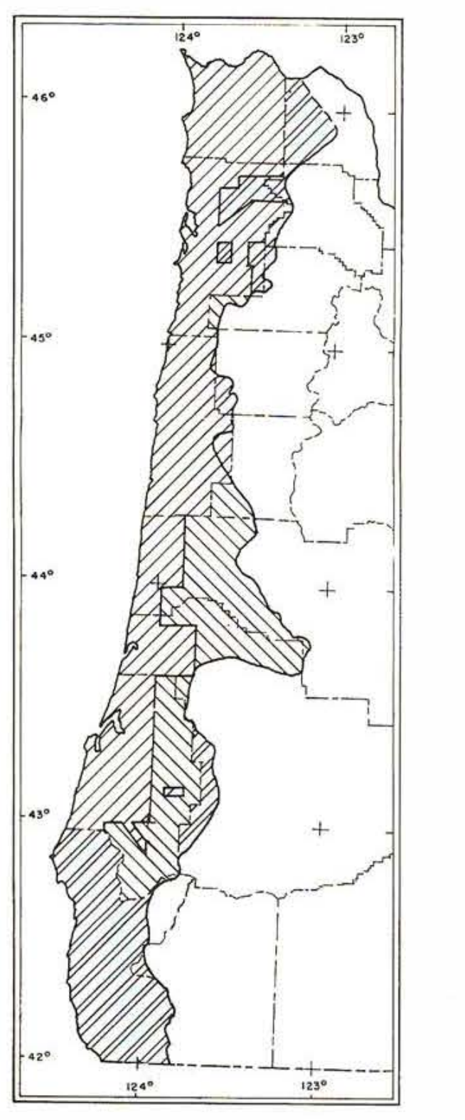
Landforms

Each landform has associated with it certain potential geologic hazards (see Table 1 in text). To assure accuracy in determining landform, this map should be used in conjunction with other appropriate references (see Selected Maps, Bibliography) and on-site inspection if necessary.

U	Uplands — *gently to steeply sloping terrain inland from beaches, dunes, and marine terraces and upslope from estuaries, tidelands, stream terraces, and flood plains.*
Sc	Sea cliff — *steeply sloping oceanside faces of headlands and terraces.*
Tfp	Stream terraces and flood plain — *elevated and valley bottom deposits of alluvium along rivers and streams.*
	Water — *ocean, estuaries, rivers, lakes, streams, and marsh (see flood hydrographs).*
Mt	Marine terraces — *flat, elevated, wave-cut platforms along the coastline brought to their present position by regional uplift (some low terraces may owe their origin to former higher sea level).*
Bd	Beaches and dune land — *gently sloping, unconsolidated, wave-transported material and dunes of unconsolidated windblown sand (does not include dunes on large marine terraces).*

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
R. E. CORCORAN, STATE GEOLOGIST

GEOLOGIC HAZARDS INDEX MAP
of the
OREGON COASTAL ZONE
(SOUTH HALF)



SUMMARY MAP OF
GEOLOGY AND GEOLOGIC
HAZARDS MAPPING

▨	Geologic hazards studies and geologic mapping completed (or in progress) on the scale of 1:62,500.
▨	Geologic mapping completed on the scale of 1:62,500. No geologic hazards studies.
▧	Geologic mapping complete on scales smaller than 1:62,500.
—	Eastern boundary of the Oregon coastal zone as defined by Oregon Coastal Conservation and Development Commission.