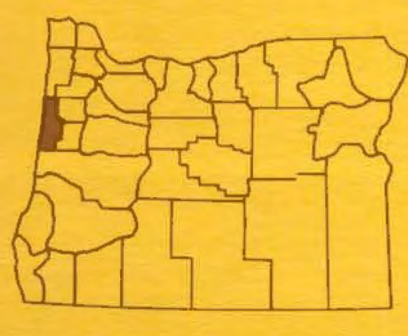
ENVIRONMENTAL GEOLOGY *of* LINCOLN COUNTY, OREGON



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

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ENVIRONMENTAL GEOLOGY *of* LINCOLN COUNTY, OREGON

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The most likely areas to search for new sources of igneous rock for aggregate are as follows: in the vicinity of Euchre Mountain; at Lambert Point; adjacent to the Calkins quarry #24; the sill in sec. 21, T. 10 S., R. 11 W., about 1½ miles northeast of Agate Beach; and in the Yachats basalt in the southern part of the County.

Quarries and gravel pits in Lincoln County are listed in Appendix A together with laboratory data and comments. The list includes quarries which have been depleted, abandoned, or are too small or remote to be economic except for local projects. Quarries in sandstone of the Tyee Formation are also listed even though the rock quality falls below present-day specifications for aggregate or jetty rock and is no longer used. Inclusion of these unusable quarries in this report should help to eliminate future time-consuming evaluation of the sites.

Nepheline Syenite

Nepheline syenite, a somewhat rare type of igneous rock, occurs in Lincoln County at Table Mountain and at Blodgett Peak. The Table Mountain rock is 300 feet thick, covers about 1 square mile, and has little overburden. It is estimated to contain 700 million tons of recoverable syenite.

Syenites in other parts of the nation have been used as a flux in making glass, but the Oregon material is not suitable for this purpose because of the iron content, which produces a dirty-brown discoloration. Beneficiation tests by the Bureau of Mines (Harris, 1962) did not remove the iron; however, the syenite could be used in the manufacture of rock wool.

Because of its neutral grey color, the syenite could also be used for roofing granules. The main factor that limits exploitation of the Lincoln County syenite for that purpose is its great distance from the principal U. S. markets. A roofing-granule plant large enough to be economically feasible would have to produce quantities in excess of the western market alone. Whether local and State interests could promote such an industry would depend upon results of a feasibility study by manufacturing and marketing experts. A plant of this magnitude could have a large impact on the economy of the County.

Lincoln County's nepheline syenite has been used successfully for jetty rock and is a potential source for future supply, as discussed below.

Jettystone

Jettystone is needed for the construction of new jetties and for maintenance, rebuilding, and extension of existing jetties. Several classes of stone are used in jetty construction and the quantities of each used on a single jetty will vary; the total often exceeds several million tons. Armor stone (class A) is placed on the outside surface of the jetty to resist the force of the largest storm waves. The interior of the jetty is built of smaller stone (classes B and C) and rubble.

The size of individual stones used in jetty construction is based on a number of considerations: unit weight of the rock, maximum expected wave height, method of placement on the jetty, and side-slope angle of the jetty. In addition, the sizes used are influenced by the maximum weight of material which can be quarried and handled with available equipment.

It is not economically feasible to make every jetty resistant to storm-wave damage. For example, to withstand the maximum expected wave height of 25 feet common to Oregon, class A select stone of 170 pounds per cubic foot would need to weigh 58,000 pounds each (Kidby and Price, 1965).

Early in the construction of the jetty at Yaquina Bay, sandstone from the Tyee Formation, quarried about 4 miles southeast of Toledo, was used. Although large stones could be quarried, they were too soft to withstand erosion. In order to prohibit continued use of this sandstone in jetty construction, U. S. Army Corps of Engineers introduced standards for jettystone which require the stone to have a unit weight greater than 160 lb/ft^3, (Table 4). Since Tyee sandstone weighs less than the minimum allowable, it can no longer be used, but unfortunately at least two other sources of igneous rock were also eliminated by this requirement.

Photo 21. Nepheline syenite at Blodgett Peak (quarry No. 57) formerly quarried for construction of Newport jetty.

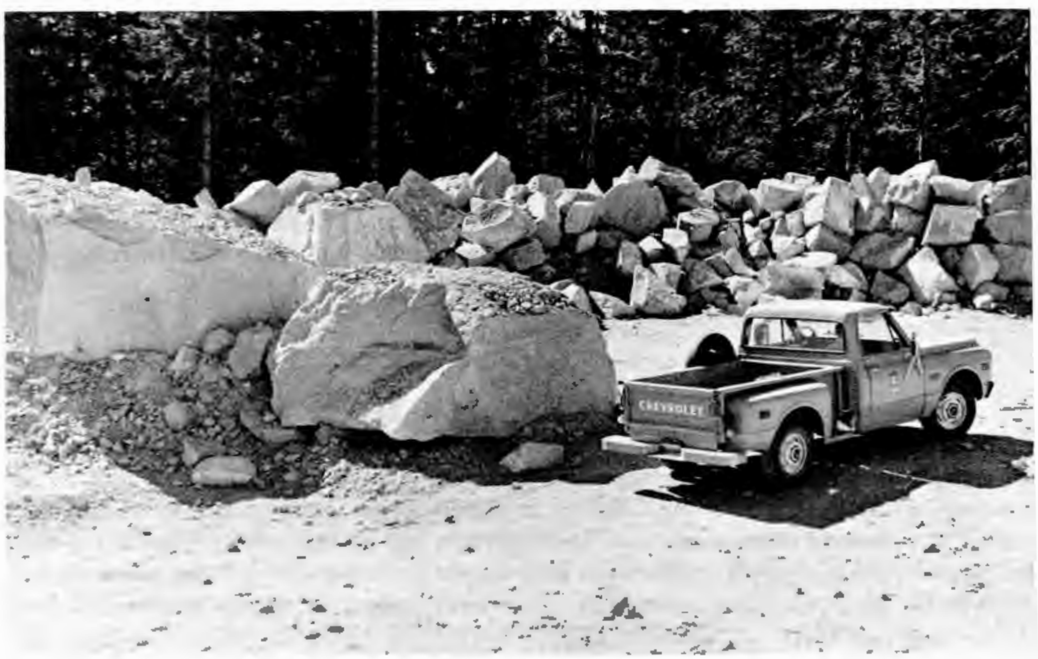


Photo 22. Thick sill of nepheline syenite on Table Mountain produces large blocks of rock (quarry No. 49).

Table 4. U. S. Army Corps of Engineers requirements for jettystone

Unit wt. of stone lb/ft^3	Select Class A Minimum Weight (tons)	Class A Min. wt. (tons)	Class B Min. wt. (tons)	Class C Min. wt. (pounds)
*160	27.8	15.2	7.6	500
165	24.8	13.5	6.8	500
170	22.0	12.0	6.0	500
175	19.8	10.8	5.4	500
180	17.8	9.7	4.9	500

*160 lb/ft^3 is minimum allowable

Approximate percentages of each class of stone used on a major Oregon jetty:

Class A stone - not less than 40 percent
Class C stone - not more than 17 percent
Class B stone - remainder

Most quarrying operations in Coast Range basalt and gabbro have been unsuccessful in producing jettystone because of close jointing in the rock. Even in apparently suitable rock, some operators produce an abundance of sizes too small to be used because they loosen big volumes of rock with a large "coyote" charge which fractures it extensively. An alternative method would be to do selective drilling and shooting.

Nepheline syenite at Table Mountain and at Blodgett Peak would appear to be suitable for jettystone, and in fact that from Blodgett Peak had been used on the Yaquina Bay jetty. The rock on Table Mountain has exceptionally wide jointing, and proper quarrying should produce the sizes needed for jetty construction and in sufficient amount to be economical; should future jetty work be required at Yaquina Bay, this stone should be considered as a possible local source of rock. Since most contracts involve several million tons of rock at prices approaching $15 a ton in today's market, use of local rock should reduce costs and be good for the economy of the County. Most recent work on the jetty utilized rock from the Calkins quarry on Cedar Creek in the Siletz River drainage.

Rip rap

Selective quarrying of Cape Foulweather, Depoe Bay and Yachats basalts, and Siletz River Volcanics will produce rock of adequate quality for shoreline and riverbank protection. These uses do not require the rigid standards set by the U. S. Army Corps of Engineers for jettystone. However, the stone should be large enough to withstand storm waves and flood currents and be resistant to weathering and erosion. For shoreline protection, a properly constructed wall should be faced with a large proportion of individually placed angular stone, each weighing a few tons. Riverbank protection can be constructed from smaller stone weighing about one ton.

at 41,800 cubic feet per second (cfs) on December 22 at 6:30 p.m., the highest in 36 years of record, and that of the Siletz River at 39,900 cfs, also on December 22, at 1:30 p.m. (Table 16). Flood hydrographs of the Siletz and Alsea Rivers for the December 1964 flood are shown in Figure 17. Discharges in the small coastal basins generally were not unusually high during the December flood.

Floodwaters inundated low-lying pasture lands and farms, forced closure of schools, curtailed or temporarily terminated many business activities, closed all major roads, downed communication lines, and isolated Lincoln County. Millions of tons of logs and other debris were swept out of the rivers to wash ashore on the beaches.

Salmon River to Siletz River: In the northern part of the County, the Salmon River and its tributaries closed travel in the Otis Junction area and along State Highway 18. Schooner Creek flooded the trailer court and school area of the Taft portion of Lincoln City, as well as the houses on the flood plain along Schooner Creek road. Drift Creek flooded extensively. The Siletz River flooded several homes at Siletz and washed several away near Kernville.

Yaquina River: High water on the Yaquina River washed away a loading dock and, augmented by the record 10-foot tides, nearly overtopped the docks along the Newport waterfront. Basements were flooded in low-lying areas. The oysters in a number of commercial beds in upper Yaquina Bay and lower Yaquina River were killed by siltation. Upstream at Toledo several lumber mills were flooded, and the municipal water supply from the Siletz River and Mill Creek was cut off. During this critical period the local radio station, KTDO, went off the air because of high water. The community of Elk City was flooded.

Alsea River: The Alsea River flooded or destroyed 80 to 90 houses and cabins from Tidewater to Waldport; 25 to 30 houseboats were lost. Resort communities situated on the flood plain were flooded; Little Albany, at river mile $7\frac{1}{2}$, was the most severely damaged. Serious sewage problems developed, and there was a shortage of potable water. At the mouth of the river, the Waldport waterfront was damaged by the high water.

January 1965

Precipitation in Lincoln County during the January 1965 storm was considerably more prolonged and greater than that during the December 1964 storm. Newport recorded 8.2 inches of rain during the December 19-23 storm, and 15.0 inches during the January 21-31 storm. Many coastal streams continued to be high into early February. This is illustrated by the discharge hydrograph of the Alsea River for the period December 16, 1964 through February 15, 1965 (Figure 18). The Siletz River registered its third largest flood of record, cresting at 43,100 cfs on January 28, whereas on the same date the Alsea River registered its fourth largest flood of record by cresting at 30,800 cfs (Table 16).

Salmon River to Drift Creek: At Otis, rainfall registered 7.44 inches on January 28 to worsen the already flooding Salmon River and its tributaries. Some of the communities making up Lincoln City faced critical water shortages due to flooded pumping stations and broken mains. To the south, Depoe Bay experienced similar difficulties. At Cutler City, Drift Creek was higher than during the December flood.

Siletz River: During the January 1965 flood, the Siletz River was over its banks for 3 days. The river rose at an average rate of 0.7 foot per hour, with a maximum rate of 1 foot per hour, for a 24-hour period, and then crested on January 28, according to the U.S. Army Corps of Engineers. Rainfall at Siletz was 5.37 inches on January 27, 5.25 inches on January 28, and then diminished to 1.25 inches on January 29.

Residents at Logsden stated that the January flood was much higher than the December flood. The Corps of Engineers estimated that the January flood was about 2 feet lower than the record flood of November 1921.

The Corps, in a release titled "Special Flood Plain Information, Siletz River," states:

"During major floods, main channel velocities would range from 3 to more than 6 feet per second. Velocities over the flood plain would vary widely, depending on location, topography, and vegetation, but would generally be less than 3 feet per second. Velocities in the order of 3 feet per second, combined with depths of 3 feet or greater, are considered hazardous.

"Siletz River responds rapidly to intense rainfall. Water-surface stages in the lower reach can rise from low water to a major flood crest in less than 2.5 days. At Kernville, river mile 0.5, major floods result in maximum water levels that are less than 3 feet higher than the stage produced by high tides, whereas at river mile 10 a major flood will crest as much as 20 feet above the stages produced by high tides."

The Corps states that during major floods the average gradient of the Siletz River along the lower 10 miles is about 1.7 feet per mile.

The high flood flows in the Siletz River in January 1965 swept away homes, barns, trailer houses, docks, and boats. A logjam formed against the bridge at Kernville, and damage to roads and highways was extensive. State Highway 229, along the Siletz River, lost approximately half a mile of roadway and its bridge at Skunk Creek, near river mile 6. The route was closed for about 4 months. Since 1965, new development in the flood plain has increased appreciably the potential for greater flood losses.

Another form of damage, not always fully recognized but nonetheless basically important, was the sediment loss accompanying the flood. The suspended-sediment load observed in the river at the Siletz gage 5 hours after the flood peak was equivalent to 102,000 tons per day at a concentration of 1,260 parts per million (ppm), according to the U.S. Geological Survey (1971). Drift Creek near Taft carried a very high 30,000 tons per day of sediment at maximum flow.

Depoe Bay: To the south at Depoe Bay, North Depoe Bay Creek washed out Collins Road and stranded a dozen families in the area.

Yaquina River: At Newport, dockside loading areas in Yaquina Bay were so silted by the January 1965 flood that dredging was required to clear the channels. High tides of 8.3 feet on January 29, driven higher by storm winds, continued the critical flooding along the coast.

At Toledo, 9 inches of rain fell in a 42-hour period. Water flooded the Arcadia district in the northwest part of town, causing the evacuation of some dwellings and businesses. The city was again without a municipal water supply because of a flooded pumping station and broken mains. Mill Creek, a municipal water-supply source for Toledo, had a peak discharge of 609 cfs on January 27.

At Elk City, flood water isolated the community and was reported 18 inches above the floor of the grocery store which stands approximately 3½ feet above street level. A Coast Guard boat was used in evacuation work in the Elk City area. The three roads out of Harlan were closed by flood waters and the sawmill community isolated. Flood waters at Eddyville isolated the community and flooded several homes.

Alsea River: The late January storm of 1965 caused extreme flood flows in the lower Alsea River and on many small coastal streams. Numerous families were evacuated as State Highway 20 was closed. The discharge hydrograph for the Alsea River near the community of Tidewater for the period December 16 - February 15 is shown in Figure 18. Sediment transport was particularly heavy in the Alsea River basin as shown by comprehensive studies made of three small streams in the headwater areas of Drift Creek, tributary to the Alsea. During the flood period January 27-29 the combined sediment load of Deer Creek, Flynn Creek, and Needle Branch totaled 1,642 tons from a combined drainage area of 2.22 square miles, more than 90 percent of the total suspended load for the entire prior 6-year period. During the flood period the maximum daily sediment concentration for the three streams totaled 4,137 parts per million. Graphs illustrating the suspended-sediment concentration, and the load and stream discharge in Deer Creek for the periods December 20-30 and January 25 - February 4, are shown in Figure 19.

Yachats River: Similar transport observations near the January 1965 flood peak in the Yachats River near Yachats indicated a suspended-sediment load of 21,200 tons per day at a concentration of 1,450 parts per million. The other coastal streams also carried large quantities of sediment for short periods during the flood peaks. A summary of the maximum suspended-sediment concentrations and loads for various streams in the County during the 1964-1965 floods is shown in Table 18.

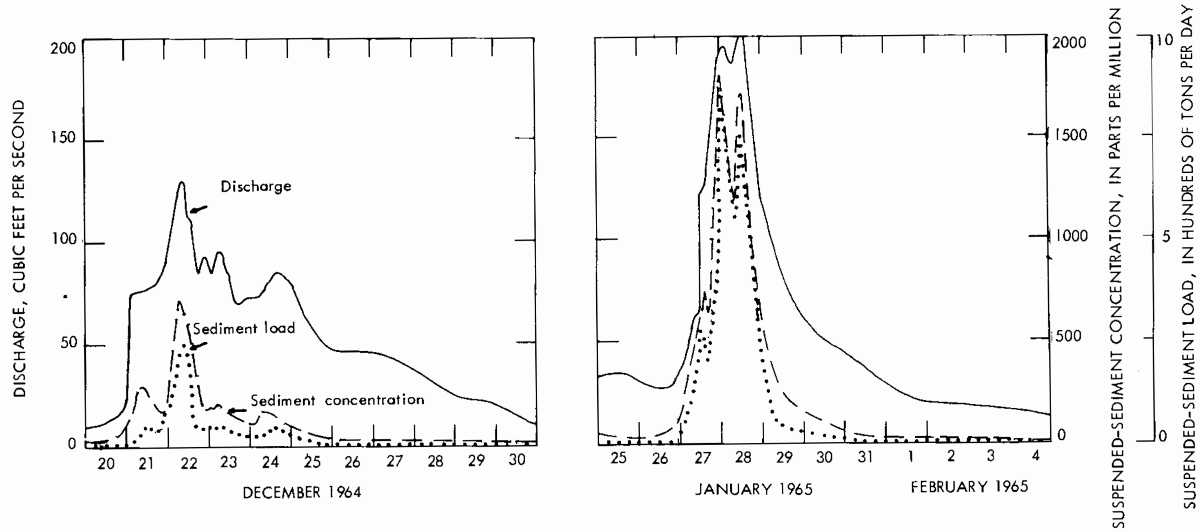


Figure 19. Suspended sediment concentration and load and stream discharge in Deer Creek, Dec. 20-30, 1964 and Jan. 25 - Feb. 4, 1965.

Flood damage, 1964-1965

Few areas in Lincoln County were left unscathed by the December 1964-January 1965 floods. Raging streams damaged homes, farm buildings, recreation property, docks, moorages, boats, summer cottages, industrial facilities, municipal water systems, public buildings, roads, and bridges; eroded banks and fields; silted channels and oyster beds; drowned wildlife and stock; and swept away valuable logs. Considerable damage to pastureland was caused by the deposition of tansy ragwort and other noxious weeds.

The giant logs stranded on the mud flats of Siletz Bay, particularly in the area west of Kernville known as Snag Alley, graphically attest to the ravages of these and past floods.

The siltation of farmland, considered for its general, long-range effect, was believed to be more beneficial than detrimental by the County Extension Agent and the Soil Conservation Service District Conservationist. Although a farmer may be temporarily out of production because of siltation, the build-up of his land is beneficial.

The forest products industry in Lincoln County was particulary hard hit by the floods. This is in part shown in Table 19 which presents damages incurred along the Siletz, Yaquina, and Alsea Rivers by the 1964-65 floods.

Flood of 1972

The month of January 1972 experienced two periods of major flooding, January 11-12 and 20-21. Storms dropped four inches of rain in 24 hours on much of the County on January 11, to be followed a week later by a 6-inch snowfall on January 18 and a 9-foot ocean tide blown higher by storm winds on January 21. The U. S. Army Corps of Engineers list a peak flow for the Siletz River of 40,900 cfs on January 20, and a peak flow for the Alsea River of 37,100 cfs on January 21 (Table 16). Of the largest floods on record for the Alsea, the 1972 flood ranks second; for the Siletz, the 1972 is the fifth in magnitude. No other rivers in Lincoln County have gaging stations.

Damages caused by the January 11-12 flood were estimated at $848,000 by the State Emergency Services Division and the Federal Office of Emergency Preparedness. Road and bridge restoration costs were estimated at $126,500 (Oregonian, 1/19/72). Major damage having been done by the first flood, it is believed that the January 20-21 flood did not add greatly to the monetary loss. President Nixon declared the County a national disaster area.

The following information about the two periods of flooding is summarized from the Newport News Times (1-13-72 and 1-27-72):

Siletz River: During the first period of flooding the Siletz River registered a high of 25.7 feet at the river gage 1 mile east of Siletz. The river fell to 18.2 feet at 8:00 a.m. the following day, showing the fast runoff characteristic of coastal streams. State Highway 229 was closed by high water about 10 miles above Kernville.

During the second flood period, the Siletz River crested at 24.6 feet, nearly a foot lower than the first flood, but flooding was worse below tidewater because of a 9-foot tide blown higher by storm winds.

Yaquina River: Elk City was isolated by both periods of flooding. High water in the Depot Slough area of Toledo flooded across old State Highway 20 and entered business buildings and dwellings in the Arcadia district. The Eddyville-Nashville road was closed by high water and slides.

During the second flood period, Toledo's water supplies from Mill Creek and Siletz River were so muddied that drinking water had to be supplied by Oregon National Guard tank trucks.

Alsea River: During the first period of flooding the Alsea River at the community of Tidewater (river mile 8½) reportedly rose from 7½ feet on the morning of January 11 to 15.8 feet the following morning and crested at about 20 feet that afternoon or evening.

During the second flood period on the Alsea, flooding was greater and extended from highway milepost 3 to head of tidewater (river mile 12). The river peaked at 25.5 feet at the Mike Bayer Campground (river mile 18) on January 21. All of the housing developments and some resorts and campgrounds on the flood plains of the Alsea River were flooded. A huge amount of debris floated out of the mouth of the Alsea River and drifted south, coming ashore on the beaches near Yachats.

Ocean Flooding

Causes of ocean flooding

Ocean flooding is unpredictable and may occur at any time throughout the year. Dr. June Pattullo, Oregon State University oceanographer, attributes this phenomenon to varying combinations of factors such as high tides, low barometric pressure, changes in ocean currents, winds, and storms. Sustained winds of gale force over a long reach of ocean can cause even a moderate 6- or 7-foot tide to build up high enough to be destructive when pushed on shore.

The commonest cause of flooding is wind that keeps the water piled up against the coast to produce storm waves and additive waves, as discussed below. Another cause of ocean flooding is the tsunami, a sea wave generated by seismic activity on the ocean floor.

Storm waves

Storm waves are large sea waves caused primarily by wind pushing the ocean onto low coasts not ordinarily subject to inundation. The waves have no relation to the tide brought about by gravitational forces except that the two may combine. The wind causing the waves is of gale (39-54 mph) to hurricane (exceeding 75 mph) force. Their size is proportional to the velocity, the duration, and the distance the wind blows across the sea.

On January 3, 1939, one of the greatest ocean floodings in history occurred when windswept high tides caused extensive damage over much of coastal Oregon.

On December 2 and 3, 1967, the entire Lincoln County coastline was battered by unusually destructive storm waves. The waves were generated by the accumulative effect of prolonged 50 mph southwesterly winds gusting to 65 mph, and tides exceeding 10 or 11 feet, the highest of the year.

Beaches everywhere were cluttered with logs and debris. The Newport area escaped severe damage, but logs were hurled onto the Nye Beach turnaround. High tides flowed over the new landfill at South Beach, but caused little damage. North of Newport, Beverly Beach State Park sustained $1,500 damage from logs floated into Spencer Creek. South of Newport, high waves did $4,700 damage to Ona Beach, Beachside, and Yachats State Parks. Large logs were washed through Ona Beach State Park, across U.S. Highway 101, and up Beaver Creek.

In the Waldport area logs and debris were washed over highways and seawalls, and much of Old Town Waldport was inundated with several feet of water. Water covered the road at the Lint Slough dike, and surged into several homes. "Old timers" said some areas were flooded that they had never seen flood.

Additive waves

Additive waves are potentially destructive sea waves that may occur under normally moderate conditions. Such waves are wind-formed by smaller waves building upon one another or by the coalescing of two or more waves moving at oblique angles from different storm areas. These built-up or multiple waves are the so-called "killer" or "freak" waves because they give no warning. The waves form regularly at sea even in mild winds, and there is always a statistical chance of their reaching shore, where great damage may result. Ships at sea have been sunk by such waves.

On February 19, 1973, a high tide of 8.7 feet was augmented by a rough sea, and "freak" waves struck several areas along the Oregon Coast at approximately the same time of day. The waves knocked one person unconscious on the beach at D River in Lincoln City, washed another off the rocks at Cape Kiwanda in Tillamook County, and broke over cars parked on the beach at Cannon Beach in Clatsop County. Fortunately there were no fatalities.

An eye-witness described the wave at Lincoln City as appearing no larger than the other large waves running that day, but that this particular wave was followed immediately by an unbreaking mound or swell of water. It was this additive force that gave the wave the impetus to run high onto the beach.

Tsunami waves (pronounced "soo-nóm-ee")

Volcanic or seismic activity in the Pacific Basin can generate shock waves that travel at great speeds (up to 600 miles per hour) and can cause catastrophic destruction in the coastal areas. These sea waves, or tsunamis, are imperceptible in the open sea, having wave lengths often in excess of 100 miles and amplitudes of only a foot or so. In coastal areas, however, the energy is concentrated by progressively shallower water, creating large waves, some as much as 100 feet in height, as the water continues to pile upon itself. Great damage along beaches and estuaries can result.

Tsunamis almost always involve more than one wave. Occasionally up to 9 or 10 waves over a period of several hours are involved. One of the middle waves is usually the largest. It is a matter of record that some tsunamis are immediately preceded by an anomalous rising or lowering of sea level.

The velocity of tsunami waves is controlled by the depth of the ocean, therefore, their arrival times at various points can be predicted once the generating area has been located from seismograph reports. No reliable system is yet available for predicting the height of tsunami waves or their effect on the various types of shorelines and estuaries. Oregon's wide continental shelf and generally high and rugged coastline with protruding headlands act to dissipate considerably the speed and impact of the waves. However, the location of most of the populace in low-lying areas and along estuaries makes the potential for tsunami damage high.

The largest recorded tsunami wave to hit the Oregon Coast occurred about midnight March 27, and early morning of March 28, 1964 (Schatz and others, 1964). This tsunami was generated about 6 hours earlier (5:36 p.m., Alaska Time) by a submarine earthquake in the North Pacific Ocean, 80 miles southeast of Anchorage. The quake (known as the Good Friday Earthquake of Alaska) caused waves to move the length of the Pacific Coast, doing catastrophic damage to some ports, particularly along the Alaskan Coast and at Crescent City, California.

Persons in the Newport area who witnessed the tsunami reported unusual churning of the ocean, followed by a huge wave that broke high and tossed logs like matchsticks. A second wave carried the logs far out to sea and exposed the ocean floor for an unusually long distance, then was followed by a wave of fairly normal size. Some of the reported effects of the tsunami wave in Lincoln County were logs and driftwood washed onto beaches, across highways in low areas, and into motel units. Some docks were washed out and a lumber barge torn from its moorings. An oyster grower in Yaquina Bay reported loss of oyster beds by wave scouring and siltation. Four tsunami waves were observed traversing Yaquina Bay, causing floating logs to change course abruptly. Several miles up the Yaquina River one witness described the water level as going down "as though a plug had been pulled," leaving the river a narrow stream until the next tsunami wave surge.

Although Lincoln County escaped the coastal onslaught with little damage in terms of monetary loss, tragically four children sleeping on the beach at Beverly Beach State Park were drowned.

Referring to the Good Friday tsunami, Dr. Peter Dehlinger, professor of geophysics at Oregon State University, stated: "Predicting the possibility of another wave such as this is impossible. The only thing we have to go on is past experience. It is known that this was the most severe wave to hit the Oregon Coast in recorded history. There is no reason to expect that such waves should become any more frequent. However, no one can say for sure it won't happen again."

The tide recorder at the Oregon State University Marine Science Center at Newport has recorded three tsunamis, all minor, since installation of the instrument in January 1967. One series of waves, lasting nearly two days, was generated 10 hours earlier by a strong earthquake off northern Japan. The waves were small and caused no serious damage. It was determined that these waves traveled about 670 feet per second, or 460 miles per hour, before slowing as they entered the shallow coastal waters.

A tsunami warning system is maintained by the National Ocean Survey at its observatories in Honolulu, Hawaii, Palmer, Alaska, and Newport, Washington. Alerts are transmitted from the Honolulu station to all participating nations. The primary receiving station for the west coast of the contiguous United States is located at the San Francisco International Airport which notifies the coastal states for general distribution. The chain of communication for Oregon proceeds as follows: State Department of Emergency Services or State Police headquarters in Salem, County Departments of Emergency Services, County Sheriff's Departments, local police and fire departments, and other local emergency personnel. Lincoln County's various police units are each responsible for patrolling a designated portion of the coastline.

The Environmental Science Services Administration of the U. S. Department of Commerce gives the following 10 safety rules for coastal residents regarding tsunamis:

1. All earthquakes do not cause tsunamis, but many do. When you hear that an earthquake has occurred, stand by for a tsunami emergency.

2. An earthquake in your area is a natural tsunami warning. Do not stay in low-lying coastal areas after a local earthquake.

3. A tsunami is not a single wave, but a series of waves. Stay out of danger areas until an "all clear" is issued by competent authority.

4. Approaching tsunamis are sometimes heralded by a noticeable rise or fall of coastal water. This is nature's tsunami warning and should be heeded.

5. A small tsunami at one beach can be a giant a few miles away. Don't let the modest size of one make you lose respect for all.

6. The National Tsunami Warning Center does not issue false alarms. When a warning is issued, a tsunami exists.

7. All tsunamis - like hurricanes - are potentially dangerous, even though they may not damage every coastline they strike.

8. Never go down to the beach to watch for a tsunami. When you can see the wave you are too close to escape it.

9. Sooner or later, tsunamis visit every coastline in the Pacific. Warnings apply to you if you live in any Pacific coastal area.

10. During a tsunami emergency, give your local emergency organizations your fullest cooperation.

Ocean flooding: Ocean flooding is unpredictable and can occur any time of the year. Its causes include storms at sea, strong westerly winds, tidal forces, and large unusual waves. Large unusual waves, although of short duration, can be very destructive. They include tsunamis caused by earthquakes on the sea floor and additive waves created when the crests of several in-phase waves are superimposed and reach the shore simultaneously.

In the past 33 years, wind and high tides have twice caused excessive flood damage along Oregon's coast. A third destructive wave was a tsunami resulting from the Alaska "Good Friday" earthquake of 1964; smaller seismic waves have occurred since that time. Although there is no accurate method of predicting the frequency and magnitude of ocean flooding, the occurrence of three damaging floods in 33 years suggests an average of about once every 10 years. Similar waves in the future will probably be even more destructive because of the greatly increased construction of residences, motels, and condominiums at or just above the normal high-tide line. The presence of logs above normal high-tide level is clear evidence of the elevations the sea can reach.

This report recommends that maximum wave elevations be determined from past experience and from data developed by oceanographers and seismologists, and that siting of future structures be based on such criteria.

Mineral Resources

Crushed rock, sand, and gravel

Crushed rock, sand, and gravel are needed for construction of roads, highways, streets, sidewalks, buildings, bridges, sewage- and water-treatment plants, and reservoir spillways.

Lincoln County, at present, requires about 400,000 tons of rock aggregate per year and this will increase to 480,000 tons per year by 1985. About six million tons of rock will have been used between 1972 and 1985. It is doubtful that the presently known commercial sites will be able to fulfill that need.

In order to delay this anticipated shortage, the present commercial quarries should be allowed to expand operations to remove the available rock at their sites. The sites should be quarried according to a reclamation plan which will leave the ground in a usable condition. Quarries may have future value as building sites, reservoirs, or sanitary landfills.

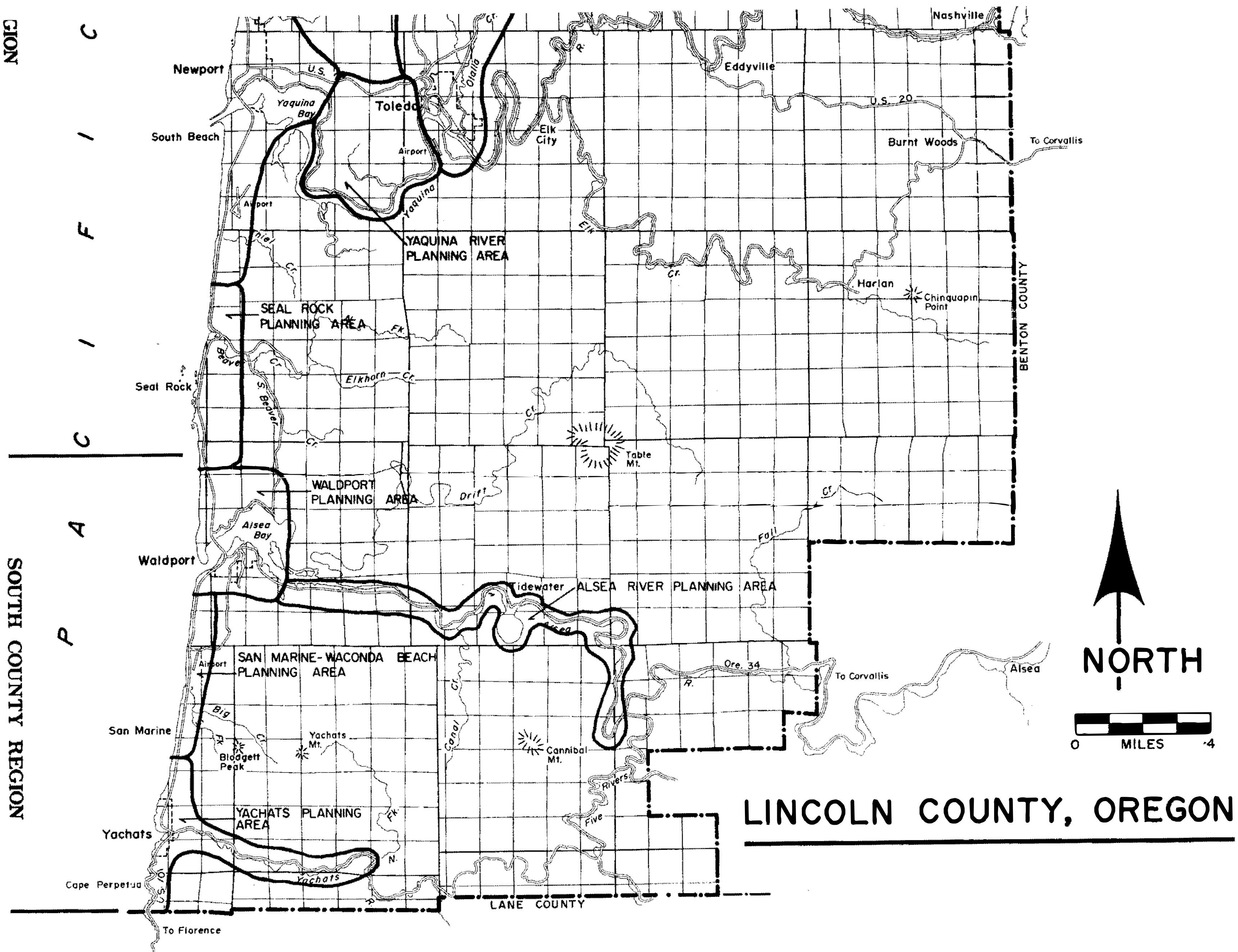
As the local supplies decline, crushed rock will need to be imported. Other sources inland do not appear to be adequate; therefore, barging of gravel from the upper Columbia River or elsewhere may be required.

Jettystone and riprap

Jettystone and riprap require a durable stone thot consistently breaks in large, angular pieces and is resistant to abrasion and weathering. In the early days, jetty construction at Yaquina Bay utilized the Tyee sandstone. Although this rock produced stones of sufficient size, the rock was not durable and the jetty disintegrated. Later syenite was used from Blodgett Peak south of Waldport. This rock was apparently satisfactory, as much of it can still be seen in the jetty at Yaquina Bay. In order to exclude the Tyee sandstone from consideration by contractors, the U. S. Corps of Engineers raised the specific gravity requirement for jettystone to 160 lbs. per cubic foot; however, this also eliminated the syenite from consideration. Basalt jettystone has been produced locally in limited quantities. Present jetty construction along the coast utilizes rock barged from Camas, Washington.

It is recommended that the specifications for jettystone be reviewed to determine if syenite from either Blodgett Peak or Table Mountain can be used on future projects in Lincoln County.

Rock suitable for riprap to protect ocean-front property and stream banks is available locally from some of the basalt units. In the northern half of the County, basaltic tuff and basalt breccia are quarried from the Siletz River Volcanics unit. Although large pieces of rock can be obtained, much of it breaks down fairly rapidly. The basalt breccia, if well cemented, is the most satisfactory local material for shoreline protection.



LINCOLN COUNTY, OREGON
NORTH
0 MILES 4
PACIFIC
SOUTH COUNTY REGION
Newport
South Beach
Yaquina Bay
Toledo
Airport
Elk City
Eddyville
Nashville
U.S. 20
Burnt Woods
To Corvallis
Olalla
Yaquina
YAQUINA RIVER PLANNING AREA
SEAL ROCK PLANNING AREA
Seal Rock
Beaver
S. Beaver
Elkhorn Cr.
Harlan
Chinquapin Point
BENTON COUNTY
Table Mt.
WALDPORT PLANNING AREA
Alsea Bay
Waldport
Drift
Fall Cr.
Tidewater
ALSEA RIVER PLANNING AREA
Alsea
Ore. 34
To Corvallis
SAN MARINE-WACONDA BEACH PLANNING AREA
San Marine
Big Cr.
Blodgett Peak
Yachats Mt.
Canal Cr.
Cannibal Mt.
Five Rivers
YACHATS PLANNING AREA
Yachats
Cape Perpetua
U.S. 101
To Florence
LANE COUNTY

Seal Rock planning area

The Seal Rock planning area extends north from Collins Creek to Lost Creek. The area is composed of a narrow band of marine terrace overlain by dune sand bounded on the west by the Pacific Ocean and on the east by upland areas. Development is occuring mostly on the marine terrace. Much of the upland area is owned by timber producers and not available for development. The marine terraces are undergoing erosion by the sea and many areas of slope failure occur along the escarpments adjacent to the beach. Where shallow enclosed basins are present on the surface of the marine terrace, a clay soil has developed, and the water table stands near the surface most of the year. Before development can attain a higher density, it will be necessary to install drainage and a public sewerage system. Homes built along the edge of the sea cliffs are subject to the damage by landslide and erosion and, therefore, adequate setbacks should be required.

The Beaver Creek area is subject to flooding; therefore, any development or structures in the flood plain should be designed to withstand this hazard. Since the slopes adjacent to Beaver Creek are generally unstable, land use along the creek should be continued as natural resources and rural residential.

South County Region

Waldport planning area

Marine terraces occupy most of the coastal land in the Waldport area. The terrace margins are retreating at the rate of about a foot a year. Here, as elsewhere on marine terraces, setbacks for structures will be necessary to assure that they are not prematurely damaged by landslide or erosion. Where terraces are overlain by sand, subsurface sewage disposal is limited, especially in the upland areas and along steep slopes. Low lying areas within Waldport have a seasonal high water table, and where urban renewal will result in heavier foundation loads, foundation studies should be made.

The large sand spit development just north of Alsea Bay will require a sewerage system, and it is anticipated there will be continual problems with drifting sand and possible future erosion along the shoreline like that at Siletz Spit. These problems should be considered in the construction and location of buildings and roads. Sand spits are also a possible source for ground water unless contaminated by the use of septic tanks. East and north of Alsea Bay the lands are either hilly uplands or low tidal-flat soils. The lowlands are subject to floods both by river and by high tides. The use of septic tanks and problems in foundation settlement are common to the tidal flat areas whereas erosion and impermeable soils as well as landslides affect the hillside properties.

South of the bay andwest of Highway 101, much of the land is underlain by sand dunes and terraces. Problems associated with this area are wave erosion and, where steep cuts are made, sloughing of the sand. A public sewerage system is necessary for development in this area.

Alsea River planning area

The Alsea River planning area extends east from Eckman Slough to the confluence of the Alsea River with Five Rivers. Immediately east of Eckman Slough the bedrock is siltstone; the remainder of the planning area is underlain by Tyee sandstone. Most of the developing areas along the river are in alluvial terrace deposits. The low terraces are subject to flooding, and development should be designed accordingly. The upper terraces seldom or never flood, and foundation characteristics of the terraces are generally good for light to moderate structures. Erosion of the stream bank is a problem in some areas and should be investigated before structures are placed adjacent to the river.

In the upland areas underlain by siltstone, the rock is impermeable as well as subject to landsliding; therefore, steep cuts or very high cuts are not recommended. The use of septic tanks will require large drain fields and low density housing. Most of the terrain underlain by the Tyee sandstone is mountainous with steep-sided canyons. The very large landslides have occurred where the dip of the sandstone beds is roughly parallel to the slope of the ground. Road cuts or other excavations made into this sandstone could cause slides where the beds dip toward the open cut.