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# From Portland to the Pacific: An Environmental Studies Tour Via the Wilson River Highway

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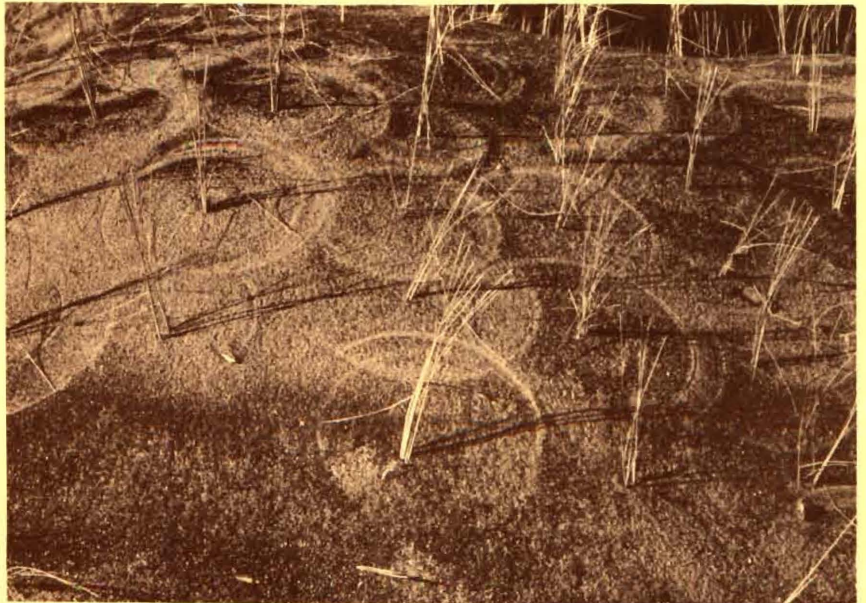
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# FROM PORTLAND TO THE PACIFIC



*An Environmental Studies Tour  
Via the Wilson River Highway  
by John O. Dart*



Department of Geography  
Portland State University

Occasional Papers in Geography  
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**Willert Rhynsbarger**

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# FROM PORTLAND TO THE PACIFIC

*An Environmental-Studies Tour  
Via The Wilson River Highway*

by

*John O. Dart*

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## I . INTRODUCTION

This field guide is the outgrowth of several years experience conducting field courses in conservation and environment and the recognition that little has been prepared for this area through which thousands of Oregonians travel each year, particularly during the summer season. In addition, the difficulties often encountered in attempting to organize a group field trip for classes at Portland State make it clear that there are many problems that could be overcome if a guide for a self-directed field experience were made available. It is difficult to develop suitable field trips for an entire class since the students do not reside on campus and most have jobs or other commitments that frustrate attempts to establish a favorable time for all. Also, experience with group field trips has shown that not all students benefit adequately since individual attention is impossible and a few tend to dominate the instructor's time. Too often the result is that many are just along for the ride.

The guide has not been prepared with a particular course or discipline in mind. It is written in nontechnical language that any college student should understand and the goal is to develop a basic understanding for an appreciation of the many elements that combine to form the variety of natural environments that can be compared and contrasted between Portland and the coast. We in Oregon are extremely fortunate to have a large, although diminishing, share of our environmental wealth remaining in our resources bank, and to have such great variety within relatively short distances of our major metropolitan center. Mile for mile, a transect from the Pacific Ocean to central Oregon will reveal greater contrasts in the major elements of the physical environment than can be found in any other section of the United States. A basic understanding of these differences and the reasons for the variations is vital for anyone, student or concerned citizen, interested in the pressing problems involved in the conservation of our natural environment. It is important that we be concerned but interest alone is not sufficient and emotional action without understanding can do much more harm than good. It is hoped that the guide can serve to develop understanding and interest in the natural environment and its resources by pointing out and explaining some of the facts and concepts regarding the natural regions between Portland and the coast.

The writer is indebted to many people for their assistance in the preparation of the guide but special thanks are due my colleagues--Dale Jolly, Thomas Poulsen, Larry Price, Willert Rhynsbarger, W. A. Rockie, and Robert Van Atta--for their advice and criticism in the field and during the writing of the manuscript, and to the Educational Coordinating Council for its financial support.

The official trip begins at the west end of the Vista Tunnel on Canyon Road and total mileage and the distances between individual sites are indicated. The time required to complete the tour will vary according to the individuals involved but it should be possible to make all indicated stops and finish the trip in five hours. The stops will not require much walking but you should wear comfortable hiking shoes and

take jackets or other apparel that will prepare you for the possible differences in weather between Portland and the coast. Other items that may prove useful are: highway map, camera, binoculars, and identification guides for plants, birds, etc.

The tour will be completed just west of Tillamook and you may have time to spend on the beach or to visit the fine Tillamook County Pioneer Museum at the junction of Highway 101 and Highway 6. The wildlife department on the second floor, with over 500 specimens of birds and mammals, may be of special interest. Visiting hours are 9 to 5 on weekdays and 1 to 5 on Sundays.

## II. FIELD TRIP

As you drive to the coast you pass through several different regions, each with its own distinctive combination of physical characteristics--such elements as climate, soils, vegetation, wildlife, and landforms--interrelated and interacting to provide a particular environment and presenting its own set of problems concerning the conservation of its resources. The regions in the order they will be seen are:

1. Tualatin Mountains (Portland Hills) -- A broad, nearly symmetrical upfold that has historically formed the western boundary for the city of Portland and its crowded urban core located on the narrow plain between the mountains and the Willamette River. In recent years the largely forest-covered ridge has been subjected to increased pressure as its proximity to the city has resulted in the construction of roads and structures that have oversteepened the natural slopes and increased the possibility of sliding and slumping of the weathered mantle.

2. Tualatin Basin -- A structural basin that has been partially filled by sediments, largely by streams flowing from the higher hills and mountains ringing the basin to the west, north, and east. The surface is low and relatively level and drainage and flooding are major environmental problems. The original vegetation, much of it grasslands, has been greatly modified as the level topography and fertile soils attracted agriculture and, more recently, urban developments of various types.

3. The Coast Range -- A relatively low, but young and still growing, north-south trending anticline with an average summit level of less than 3,000 feet but constituting the major topographic barrier between the Willamette Valley and the coast. The barrier nature of the range has relatively modest implications for modern lines of transportation and communications but is of great significance in its influence on precipitation and therefore indirectly on vegetation, stream patterns, and many types of gradational landforms.

The moist, mild climate has favored the growth of fir and hemlock that have been the major utilized resource although a large section of forest through which you will be driving was killed by a series of fires between 1933 and 1951.

4. Tillamook Delta -- This low, level flood plain is located south and east of Tillamook Bay and represents a portion of the bay which has been filled with alluvial materials transported by several streams flowing down the steep western slopes of the Coast Range and building coalescing deltas into the bay. The fine silt represents a major resource and is the basis for the chief economic activity of the delta, dairy farming. Periodic floods constitute the major environmental problem, threatening structures on the plain and causing rapid ecological and physical changes in the bay.

5. The Coastal Strip -- The Oregon Coast is one of the most varied and beautiful coastlines in North America and the short distance along which you drive reveals the beauty and contrasts very well. Rugged headlands with steep cliffs jut into the sea. Isolated stacks dot the off-shore area and sandy beaches lie protected from vigorous wave and current action by the protruding capes. Estuaries with their complex ecological characteristics and rapidly changing morphology are major areas of environmental concern.

Some of the contrasts in the physical environment, the resources and their utilization, and the problems of these regions will be obvious. Other differences may be much more subtle, more difficult to perceive, and yet just as significant. You will drive through and examine these regions separately but you must be alert to the many ways in which they are interrelated and interdependent if you are to gain the overall impressions and awareness that are necessary to adequately understand and appreciate the environment and its resources.

## 0.0

The field trip begins on Canyon Road at the west end of the Vista Tunnel at the foot of the Tualatin Mountains or Portland West Hills. Check your odometer as you emerge from the tunnel since distances in the guide will be determined from this point.

The Vista Tunnel, completed in 1971, was constructed to improve highway connections between Portland and the Tualatin Basin through the Tualatin Mountains. Structurally these mountains are a nearly symmetrical anticline or upfold trending northwest to southwest with each side steepened by faulting paralleling the trend of folding. The fault on the east flank through which you have just passed is a major regional fault at least fifty miles long. This folding has developed in Columbia River basalt, the same lava that extends from Idaho to the Pacific Ocean and covers wide areas in the eastern sections of Oregon and Washington. The basalt reaches an altitude of 1700 feet and extends westward beneath the Tualatin Basin. Above the Columbia River basalt and exposed in the higher portions of the mountains and in sections along the west side is the Boring lava, resulting from a more recent (late Pleistocene) and local series of eruptions.

You are ascending a steep, narrow stream-cut canyon occupied by a six-lane highway. This notch through the Tualatin Mountains allowed relatively easy access between the Tualatin Basin and the lower Willamette River and was first used by Indians. Early settlers constructed a crude road that was gradually improved and widened to six lanes. It is already filled to capacity during rush hours and still is beset with problems, particularly during the winter. In the shade of the canyon the frost and snow remain longer during the day. This is one of the first thoroughfares in the Portland area to experience difficulties with snow and ice during periods of bad weather.



# GEOLOGIC TIME CHART

AGE DIVISIONS			DOMINANT LIFE		TIME			
ERA			ANIMAL	PLANT	DURATION IN MILLIONS OF YEARS		BEGINNING MILLIONS OF YEARS AGO *	
	PERIOD	EPOCH			ERA	PERIOD		EPOCH
CENOZOIC	QUATER- NARY	RECENT	MAN		63 011	1.011	0.011	
		PLEISTOCENE				1	1	
	TERTIARY	PLIOCENE	MAMMALS BONY FISH BIRDS SHELL FISH ARTHROPODS	FLOWERING TREES AND SHRUBS		62	12	13
		MIOCENE					12	25
		OLIGOCENE					11	36
		EOCENE					22	58
		PALEOCENE**					5	63
MESOZOIC	CRETACEOUS		REPTILES	CONIFERS CYCADS GINGKOS FERNS	167	72	135	
	JURASSIC					46	181	
	TRIASSIC					49	230	
PALEOZOIC	PERMIAN		AMPHIBIANS INSECTS	SCALE TREES CORDAITES TREE FERNS CALAMITES	370	50	280	
	PENNSYLVANIAN					CARBON- IFEROUS	40	320
	MISSISSIPPIAN						25	345
	DEVONIAN		SHARKS LUNGFISH	PRIMITIVE SCALE TREES AND TREE FERNS		60	405	
	SILURIAN**					20	425	
	ORDOVICIAN**		CORALS BRACHIOPODS ECHINODERMS TRILOBITES	FUNGI ALGAE		75	500	
	CAMBRIAN**					100	600	
PRE-CAMBRIAN	GRENVILLE OROGENY**		BEGINNING OF PRIMITIVE PLANT AND ANIMAL LIFE		4000		1000	
	OLDEST KNOWN ROCKS IN NORTH AMERICA**			2600				
	OLDEST KNOWN ROCKS (MURMANSK AREA)**			3400				
	PROBABLE AGE OF THE EARTH			4600				

\* ADAPTED FROM KULP, 1961

\*\* ROCKS OF THIS AGE NOT KNOWN TO EXIST IN OREGON

STATE OF OREGON  
DEPARTMENT OF GEOLOGY  
AND MINERAL INDUSTRIES1:6 EWMH  
17 JAN 61

## (1.1) (Distance between consecutive sites.)

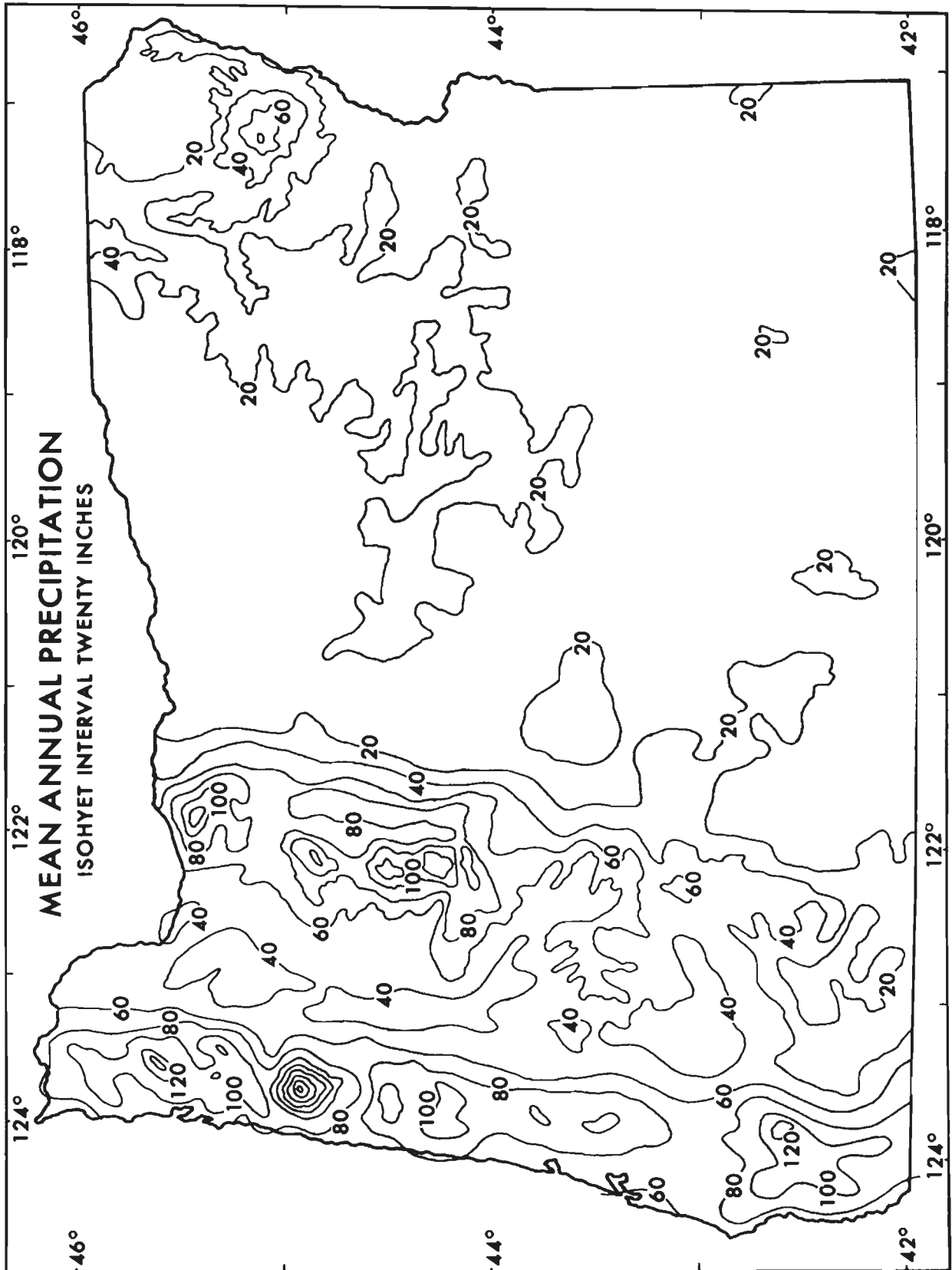
1.1

Entrance to the Portland Zoo. Notice that the road cuts are protected by a large mass of basalt rocks. This is an area that is very susceptible to sliding. A fine clayey material, the Portland Hills silt, forms an extensive cover over much of the Tualatin Mountains and is thought by some experts to be wind-deposited dust (loess) derived from the Columbia River Valley and the Tualatin Basin during late Pleistocene (Plate 1). Large quantities of glacial rock flour were deposited by flood waters and dried. Winds then picked up the fine angular particles and deposited them over adjacent highland areas. The silt is irregular in depth, largely absent on the steeper slopes but found to depths of as much as 100 feet in favored locations. When the equilibrium of the natural slope is disturbed either by downcutting of streams or by man this material becomes very unstable, particularly during the wet winter period. When water saturates the silt it adds weight, provides lubrication, and the mass begins to move downslope. When the highway was widened in 1959 severe sliding occurred and extended from the road to the site of the zoo where extensive fractures and movements of several feet endangered the buildings then under construction. Several methods have been employed in the attempt to stabilize the slopes, including the drilling of a series of wells connected to tunnels at the bedrock level and designed to drain the water and prevent saturation of the silt. This has worked very well in certain situations but did not appear to be an adequate means of protection here. However, rocks placed in a deep trench and extended up the face of the road cut seem to have stabilized this particular slide, at least for the present. If you wish, take the exit to the zoo and drive through the parking area to the extensive grass-covered slopes above the zoo and OMSI. There are many evidences of sliding in the bowl-shaped depression with its very irregular surface. Also, note that many of the trees are offset and growing at strange angles; additional evidence that this is an old landslide area with surface material in the process of irregular downslope movement even before man entered the scene and accelerated the action.

## (1.0)

2.1

Approaching the summit you can see ahead a number of tall radio and TV transmitting antennas. This is the highest portion of the Tualatin Mountains close to Portland. Also on the right are several office buildings and apartment complexes indicative of the recent move of many such features into the area. You should be alert to the changing patterns of land use that can be seen as you move out from the downtown core. Note the amount of land that has been transformed from its natural state to agriculture and more recently to various types of use as the urbanizing influences extend westward. As you descend the west flank of the Tualatin Mountains there are additional apartments and a large cemetery on the right.



(.8)

- 2.9 On each side of the road are outcrops of the Boring lava, the younger and more local flows which are resting upon the Columbia River basalt over much of the Tualatin Mountains.

(.9)

- 3.8 The highway is cutting through the westernmost outcrop of Boring lava. You are moving from the Tualatin Mountains into the eastern edge of the Tualatin Basin.

(.3)

- 4.1 At three o'clock is the new St. Vincent's Hospital relocated here from the northwestern edge of downtown Portland. Also, just to the west at three o'clock is the old Tektronix plant. The company's major and impressive, campus-like industrial complex is now located just northwest of Beaverton. An important manufacturer of high grade oscilloscopes, it is an excellent example of the type of clean industry producing high value, low bulk goods that most cities in the northwest would like to attract.

(.3)

- 4.4 To the left is the Cedar Hills Shopping Center, one of the earlier centers along this highway. On the right is a large nursery greenhouse and adjacent to it a cultivated field. There are extreme and interesting contrasts in land use in this area and in the next mile you will see barns, pastures, cultivated fields, scattered stands of Douglas fir and maple, and to the left a large lumber yard. This area is on the upper terrace of the Tualatin Basin with an elevation of 300 feet and you will soon descend to 200 feet in the valley of Johnson Creek.

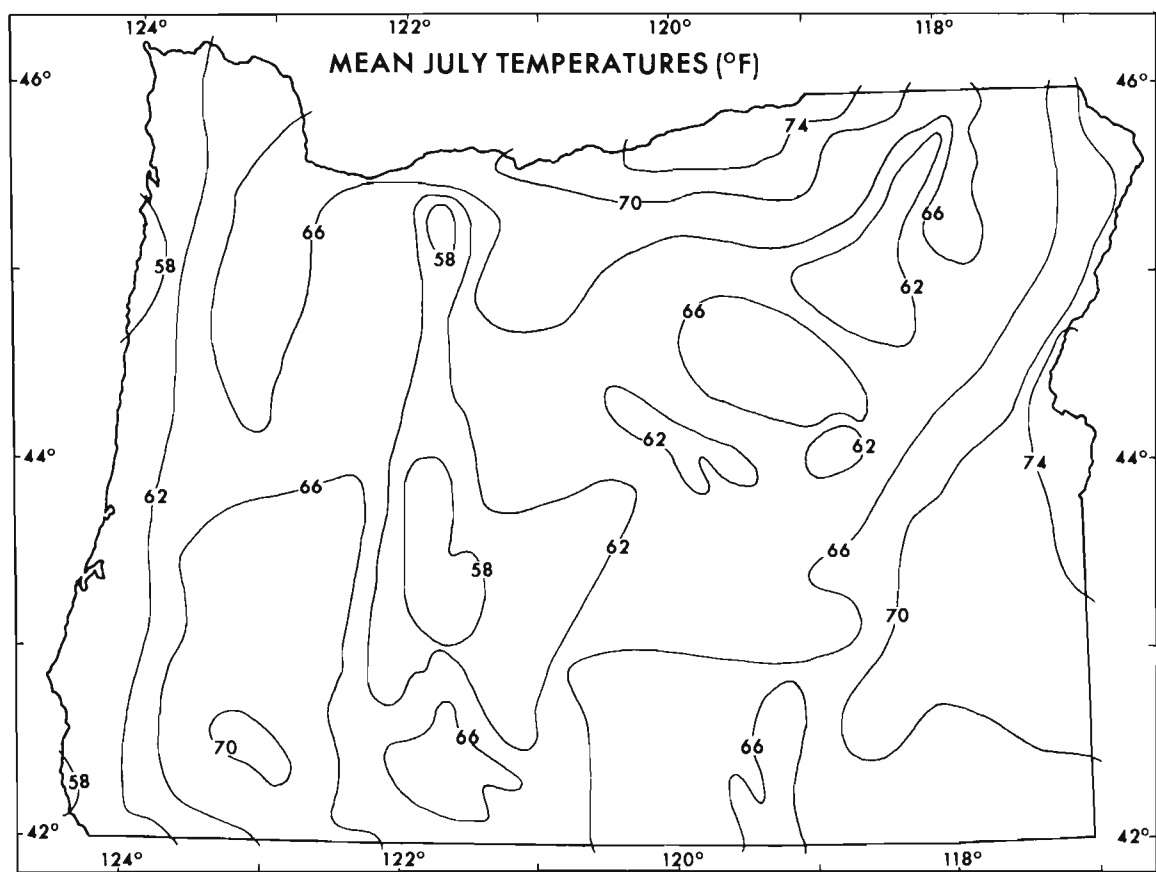
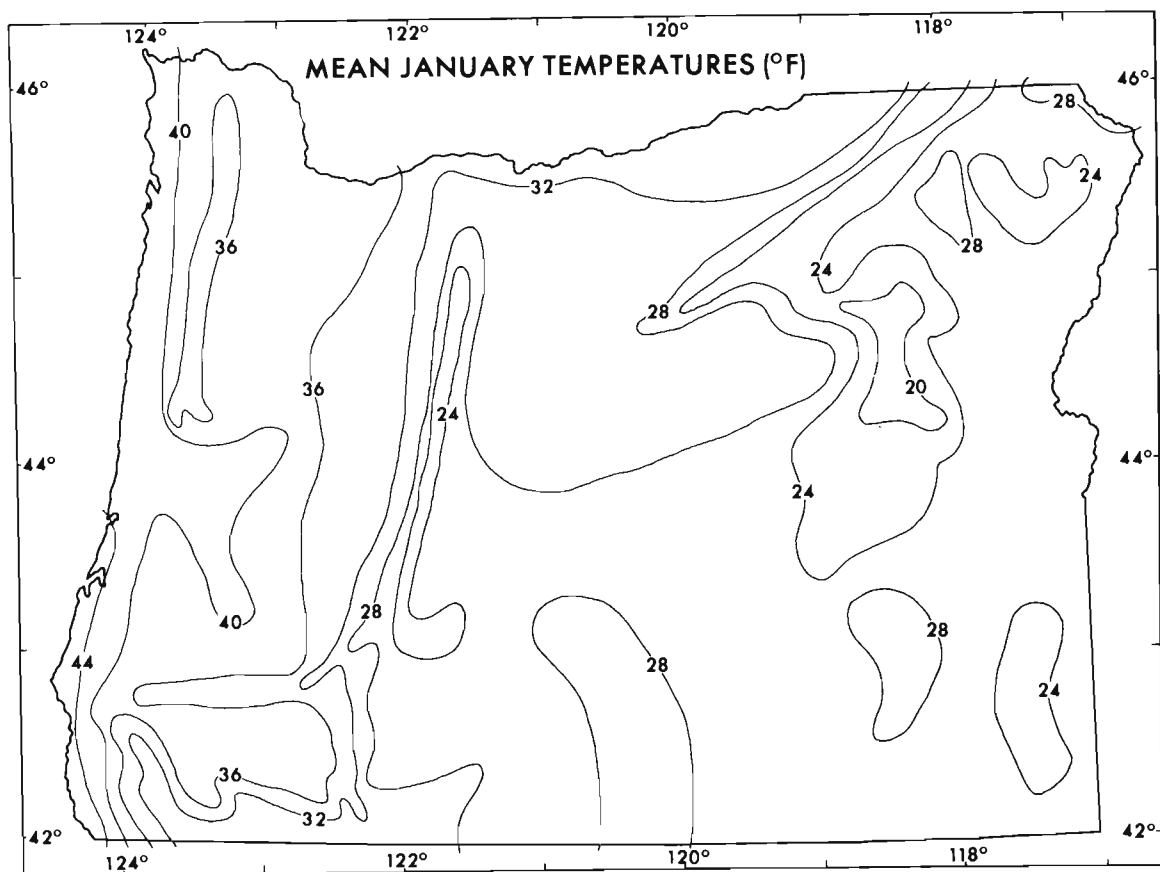
(.5)

- 4.9 Stop Number One. Here the highway crosses over Cedar Hills Boulevard. Take the Cedar Hills Boulevard-Barnes Road exit and drive parallel to the freeway for approximately .2 mile until there is room to park along the right side of the road. You are now within the Tualatin Valley, a bowl-shaped syncline underlain by Columbia River basalt and partially filled with stream and lake deposits (Troutdale sediment and Willamette silt). The basalt structure is depressed to a depth of about 1,300 feet below sea level in the center of the valley. The higher outer edges represented by the sharply uptilted basalt can be seen in almost every direction. Straight ahead is the Coast Range, and along its eastern edges you will soon see the upturned layers of

basalt. At three o'clock are the Tualatin Mountains bending around to six o'clock, and at eight o'clock is the Cooper Mountain-Bull Mountain ridge that divides the southern from the northern part of the basin.

The Tualatin River drainage basin has a total area of 700 square miles. Of that area, the main valley plain includes nearly 350 square miles in rectangular form about 30 miles long and 10 miles wide. The plain has an elevation ranging from 120 to 250 feet. Although the fill has been deposited over a long period of time since the initial formation of the basin and is still continuing, a major portion was deposited by flood waters of great volume and energy that ponded the area in late Pleistocene time. A lobe of the Cordilleran Ice Sheet advancing down from the Purcell Trench in the Idaho panhandle acted as a valve and impounded the drainage in Montana west of the Continental Divide and south of the ice front. This area is drained by the Clark Fork River which emerges from its narrow valley via Pend Oreille Lake in northern Idaho. The drainage system was ponded to an altitude of 4,150 to 4,200 feet and the lake (Lake Missoula) contained more than 500 cubic miles of water. The sudden release of lake water with a peak discharge of about 2 1/2 cubic miles per hour resulted in flood waters more than 50 times the maximum historic flood stage of the Columbia River measured at The Dalles. This vast volume of water flowing past the present Portland area apparently became restricted downstream near Rainier and backed into the Willamette Valley and the Tualatin Basin. Glacial erratics have been found at elevations of 350 feet in the Tualatin Basin indicating that flood waters were at elevations of 350 to 400 feet above sea level. This resulted in the deposition of many materials on the lake floor and more recently streams have added alluvium to bring the basin to its present level.

You will notice that the stream pattern is not very well marked. Most streams have not cut deeply into the surface and along the outer edges of the basin deposition is more significant than erosion. Streams flow with steep gradients from the higher areas surrounding the basin, particularly from the Coast Range to the west, and carry large amounts of material. As they strike the relatively flat floor of the basin their velocity is reduced, and they are forced to drop most of their load. This has resulted in flooding conditions over much of the basin, particularly that portion to the south along the main stream, the Tualatin River. Flooding has occurred for many years but flood damage has increased greatly during the past 50 years. This is not due to weather changes but is largely the result of unrestricted encroachment by man upon the flood plain. In this northern part of the basin, poor drainage rather than serious flooding is the major problem. Sections of the farm area through which the highway runs is restricted from attaining its potential by these conditions. Poor drainage also has been a serious problem as the region becomes urbanized. Septic tank failure and other problems resulting from water saturated soils in winter make building much more difficult than would appear as you drive through the area during the summer. Where drainage is not a problem the area has excellent agricultural





potential and the highway traverses one of the largest areas of Oregon's relatively limited amount of Class 1 land--land that can be utilized for agriculture with no serious restrictions on its production. Ironically, land that is ideal for agriculture also has very few restrictions for non-productive uses. One of the most obvious characteristics of the eastern basin is its rapid urbanization. The recent development of large housing tracts, apartment houses, shopping centers, and industrial plants has transformed the area from agriculture to a region where non-farm uses are almost dominant. Highway traffic has replaced the railroad, releasing industries from railhead locations, and the automobile has allowed people to live farther from their place of work. With the recent widening of the highway to four lanes the rate of encroachment of non-agricultural uses is increasing.

Land use here is largely in response to situation, the location in relation to the center of the city. The site factors such as soils, drainage, and exposure have played relatively minor roles in the actual location of these various urbanizing uses. The decision to locate housing and other projects has been made by private developers, not planning commissions and may or may not be vetoed by the planning commission. The developer is responsible solely for the planning and internal development of his particular unit. He has not been responsible and often is not aware of the need to plan for the whole area and the way in which each development fits into an overall master plan. In many cases there has not been sufficient attention given to the physical restrictions of the environment and this has caused many problems for planning commissions, planners, and certainly for this area in the future.

When you are ready to proceed, continue to drive parallel to the freeway until you are able to enter it from the right.

(.7)

- 5.6 Cedar Hills to the left and Marlene Village just beyond it are residential areas that were developed soon after World War II and have continued to expand. Originally they were on opposite sides of Johnson Creek and separated by almost a mile, but today the growth of each development has brought them together. To the north of the highway is Cedar Mill, one of the older farm villages which has clearly outgrown that function. The Sunset Science Park and beyond it Sunset High School indicate the urbanizing influences in the area.

(2.0)

- 7.6 Cornell Road Overpass. Cornell Road was an early route from the Tualatin Basin through the Tualatin Mountains reaching the Willamette several miles north of

Canyon Road. In this area note the assortment of older farmsteads and the newer houses that are not connected with agricultural activities.

(1.6)

- 9.2 Overpass at 185th. To the right is one of the largest of the new housing developments. Only a few years ago this area was considered to be too far from Portland for a suburban development of this kind but the extension of the four-lane highway and the rapid westward movement of the urbanized area have changed the thinking of developers and home buyers. Notice that rapid expansion of this development is continuing. In contrast, the area to the left of the highway remains largely unchanged from its basically rural appearance with open fields, scattered farm houses and a picturesque old barn. One small field next to the highway is usually planted to wheat or oats and harvested by the early method of binding and shocking the grain. Look for the neat rows of shocks in the field if you pass here in late August or early September.

(1.0)

- 10.2 Bridge over Rock Creek. Rock Creek, one of the larger creeks in the basin, flows from the Tualatin Mountains through the eastern edge of Hillsboro and joins the Tualatin River to the south. As noted earlier, flooding has been a serious problem in the lower parts of the basin along the Tualatin River. In 1953, the Corps of Engineers recommended channel changes in the Tualatin River and the construction of several storage reservoirs on the tributaries. The Bureau of Reclamation is administering the construction of the largest of these dams on Scoggin Creek near Gaston at the eastern edge of the Coast Range. The Soil Conservation Service has made studies on the upper courses of Rock Creek and McKay Creek and has announced that funds have been authorized for final studies and construction. Construction of these dams was originally scheduled for 1967, but when or if it will begin is uncertain. One of the major problems has been the reluctance of many farm owners to sign long-term contracts for summer irrigation water when they do not know how long they will continue to farm due to increasing land speculation and real estate taxes. Meanwhile construction costs continue to climb and investors who have purchased land to the north to take advantage of the higher values resulting from the close proximity to the reservoir recreational areas become increasingly restive.

(.5)

- 10.7 Power Substation. To the left is a large Bonneville Power Administration substation serving the surrounding area. The main power lines are running east-west to the right of the highway and cross the highway a short distance to the

west. The highway is now traversing one of the largest areas of Class 1 land--land that has the highest potential for agricultural use with high fertility and no serious limitation placed on its use by such factors as slope, drainage, or structure. In this light it is interesting to note that most of the crops are those that have considerable tolerance and could be raised in many areas with more limited capabilities. The dominance of small grains and other largely extensive types of production is clear indication that this prime land is not being utilized at its highest level. Wheat yields are high with 70 or more bushels per acre not uncommon but the dollar yield makes this a very marginal type of farming compared to the intensive production of truck crops, berries, etc. There are several apparent reasons for this situation: labor problems, particularly those associated with harvesting, problems of marketing, high cost of specialized farm machinery, and others. However, the most compelling factor has been noted along the way from Portland: the continuing westward encroachment of urban uses upon these outstanding agricultural lands. In many cases the land is being held rather than farmed, waiting for the most profitable time to sell or develop. Extensive farming of small grains either by the owner or by a renter provides some income with which to pay rapidly rising real estate taxes, with relatively small outlay per unit of land. Unfortunately the same characteristics that make this Class 1 agricultural land also assure the developer that there are few costly limitations imposed upon construction of homes, streets, sewers, or septic tanks. The state and the nation cannot afford indefinitely to allow prime agricultural land to disappear beneath houses, shopping centers and freeways. Even some fervent ecologists seem largely unaware of or relatively unconcerned with the permanent loss of one of our most basic resources.

(1.1)

11.8 Riviera Volkswagen. To the right is one of the few major urban uses that has been introduced this far to the west. It occupies a field that was planted to small grain. When ground was broken for this structure in the summer of 1971 the wheat was ripening and almost ready to harvest. Apparently construction could not be delayed and the crop was destroyed. In addition to the remaining open fields a few orchards, chiefly filberts, can be seen. Orchards have never been predominant in this area in contrast to other sections to the south as around Newberg, Carlton, and Yamhill. Orchards represent a better use of Class 1 lands than small grains but they are not the highest utilization since the tree crops can be raised on Class 111 lands where limitations are imposed by slope and other negative factors.

(2.9)



Fig. 1-A Looking west from the Joe Meek historical marker. Note the level surface of the basin, the fields of grain on both sides of the highway, stands of second-growth forest, and the Coast Range in the background. (Mile 14.7)



Fig. 1-B A thick, even-aged stand of second-growth Douglas fir. Deciduous trees grow along the edges but are largely absent under the evergreen canopy. (Mile 15.2)

- 14.7 Stop Number Two. Oregon Historical Marker. Pull off to the right of the highway and stop in front of the Joseph L. Meek marker. The original Meek farmstead is still owned and operated by his descendants. To the southwest is the old Scotch Church where Meek is buried, and a good example of New England church architecture. Some of the earliest land to be settled in western Oregon was in the Tualatin Basin. Trappers and traders from Fort Vancouver acquired land in the North Plains area, attracted in part by the natural grass which provided good grazing for cattle, one of the first major products. The grass vegetation was also one of the major reasons for the fertile black chernozem soils of the region. It has been suggested that the grass lands resulted largely from the Indian practise of periodic burning. Indians with permanent villages along the lower Columbia came into the Willamette and Tualatin Valleys to hunt and started fires to drive game into the open. This also provided more forage for game and undoubtedly caused a number of long term ecological consequences. At any rate it is clear that twentieth century man is not the only one who had a role in changing the landscape of Oregon.

The scattered forest is a combination of coniferous and deciduous species with Douglas fir, mainly second growth stands, the dominant coniferous type and the Oregon white oak the most important deciduous type. The oak often indicates a droughty condition and the poor moisture-retaining characteristics of the soils. Some of the scattered stands of oak and large individual trees were here before the arrival of the first white settlers.

(1.0)

- 15.7 McKay Creek Bridge. This creek has already been mentioned in connection with Rock Creek. Just beyond the bridge to the right can be seen a portion of the sawdust pile of an old mill used to process logs from the basin and nearby hills. A small reservoir on McKay Creek provides the pond for log storage.

(.7)

- 16.4 Hillsboro-North Plains Overpass. To the right, North Plains is an older, relatively unchanged settlement with economy based on its functions as an agricultural trade center and the processing of logs.

(2.1)

- 18.5 Just before you reach the Dersham Road overpass note the old saw mill back from the left side of the freeway. Originally the plan was to call your attention to the Wigwam burner, a large, slightly rounded conical metal form that was used to burn the waste material from the mill operations and spewed large amounts of

smoke and ash into the air while doing so. These burners are disappearing from the Oregon scene as the mills, particularly the larger, modern integrated ones are developing uses for the former waste material, and also because the state has banned their use. A few still operate on a conditional basis, but all are to be shut down by 1975. Unfortunately, this one was removed early in 1973 but perhaps this provides an even better illustration of environmental change in Oregon.

(.7)

19.2 Bridge over the East Fork of Dairy Creek. You are passing over a broad almost level surface that is the shallow valley of the east fork of Dairy Creek. The land here is no longer Class 1 mainly because poor drainage imposes restrictions upon agriculture. Much of the land is tiled to improve the subsurface drainage and to allow the land to dry out and become tillable earlier in the spring. With an elevation of approximately 170 feet this is the lowest portion of the basin you will cross. An additional explanation for the poor drainage may be the clayey characteristics of the lake bed or stream deposited subsoil, or that Dairy Creek is not able to maintain an adequate channel through the debris that it must deposit as it moves from the steep slopes of the mountains to the broad level floor of the basin.

(.8)

20.0 Wilson River Highway Junction. As you turn to the left, leaving the Sunset Highway and taking the Wilson River Highway (Oregon 6), you are crossing the channelized course of Bausch Creek. The area's serious drainage problems are being corrected by straightening and deepening the creek which allows the water to move more rapidly through its valley. Fields on each side of the channel have been tiled to move water into the main stream more efficiently. A water control structure has been installed in the main channel which allows the farmer to flood the field during the winter. Ducks are encouraged to land and hunters are given some activity when the land is in no other use.

(1.1)

21.1 To the right is a rather large stand of second growth Douglas fir mixed with oak. Notice that the topography on the right is becoming more rolling with considerably more relief than that of the basin floor over which you are driving. This is the eastern edge of the Coast Range as it rises from the western rim of the Tualatin Basin.

(.7)





**Fig. 2-A** A typical scene in the western Tualatin Basin with a combination of small grains and irrigated berries in the foreground: orchards, small grains, and second-growth forest on the rolling foothills of the Coast Range in the background. (Mile 20.5)



**Fig. 2-B** A clean-cultivated prune orchard on rolling Class III land near Timmerman Road. The eastern margin of the forested Coast Range appears in the distance. (Mile 28.0)

21.8 You are passing through the village of Wilkesboro. The age of the houses indicate that this is an older settlement and beyond the present radius of Portland urbanization. The railroad tracks of the Southern Pacific and Burlington Northern lines just beyond suggest that this may have been a factor in the location and function of the settlement.

(.8)

22.6 As you approach the Banks Junction you can see the town of Banks to the right. Banks has functioned as an agricultural trade center and as a processing center for timber brought from the Coast Range. It appears to be beyond Portland urban influences, but the parking of cars at the junction each day during regular working hours suggests a common suburban phenomenon: car pools forming here for the daily trip to the city. A check on local real estate prices also will indicate the influence of urbanization even in the western basin.

(1.0)

23.6 Note the area to the right that is somewhat lower and poorly drained. The vegetation is an association of willow, cottonwood, and other moisture-tolerant plants and is the most obvious indication of high water table during the summer. In winter, water several feet deep covers much of this area despite the straightening and deepening of Cedar Creek flowing to the east and parallel to the highway. As you proceed west, note the sharp contrast between the steep south side of Cedar Canyon to the left where tilted layers of Columbia River basalt outcrop, and the flat alluvial surface on the right. It appears that a major reason for the poor drainage is the entrance of Sad and Park Farm Creeks into the lowland from the steep slope to the right. These small but high gradient streams have carried large amounts of material and dropped most of it in the flat narrow valley. Streams working with this low gradient have been unable to maintain adequate flow through the alluvial debris.

(.9)

24.5 Stop Number Three. Pull over to the left, park and get out of the car so you may examine the characteristics of the materials exposed in the first of three large road cuts extending along the highway for the next half mile. These road cuts with the brick red, highly weathered rock are in Columbia River basalt and indicate that you have traversed the major part of the Tualatin Basin and are now on the western edges of the syncline. The reddish color is due to deep weathering and the resulting hydrated iron oxide is produced by the decomposition of iron bearing minerals in the basalt. This laterization is most pronounced in areas of moist tropical climate and its presence here is evidence of past and present relatively warm moist climates

that has caused weathering to depths of 40 to 60 feet. This deep weathering in the highly jointed and fractured basalt is most pronounced at the corner and edges of the blocks. These portions are rounded before the flatter surfaces and results in spheroidal forms, best seen in the third of the road cuts. The rounded rocks result from weathering and are not stream modified boulders as they may appear to be. The thick lateritic weathered mantle derived from the underlying Columbia River basalt has been utilized in the past as a source of iron. It has been mined in the Columbia River area and carried up the Willamette to Oswego where it was smelted into pig iron for use in Portland foundries. There are also areas where the residual soil has high alumina and low silica content and is a potentially commercial bauxite ore, a hydrated aluminum oxide. To the north, Alcoa controls the mineral rights to thousands of acres and eventually the ore may be mined.

This road cut is an excellent site to observe some of the major features of weathering and mass wasting on a small scale. At the base of the slope are accumulations of talus material that has rolled or slipped down from the steeper slopes above. There are also many minor forms resulting from stream erosion and mud flows that make this a very interesting laboratory to study the effects on a small scale of these various means by which materials are moved from their source to a lower level.

(.8)

- 25.3 On the left is the third of the three road cuts mentioned at the previous stop. Note the boulder-like forms resulting from spheroidal weathering.

(1.1)

- 26.4 The highway widens to three lanes as it ascends an eastward extension of the Coast Range.

(.3)

- 26.7 On the right is a small planting of conifers for Christmas trees. You will not see many examples of this activity on this trip but it is an industry that has become quite significant along the edges of the Willamette Valley and on the higher and rougher lands within the Valley. Each year thousands of young trees are cut and shipped to California, to eastern cities, and to Hawaii.

(.2)

- 26.9 A road cut exposing Columbia River basalt can be seen on the right. Note the contrast between the columnar lava in the lower exposure and the deeply weathered

and broken flow above. Basalt that reaches the surface and flows easily over the existing terrain and then cools slowly often exhibits this type of jointing. As the massive flow cools it contracts and vertical fracturing or jointing of the rock is the result. When lava cools more quickly the flows develop a much more irregular pattern of fracture with jumbles of broken blocks occurring as the surface portion solidifies and the fluid lava beneath continues to flow.

As the highway climbs toward the crest of these hills it passes from the Columbia River basalts to underlying marine mudstones which are quite susceptible to sliding. Note that many slopes have evidence of sliding or slumping.

(.4)

- 27.3 On the left is a thick stand of second growth Douglas fir. These trees exhibit some of the characteristics that have made clearcutting the usual method of harvesting. Note the thick stand, the even size and height of the trees, the absence of plant growth on the forest floor within the stand, and the process of self-pruning by which each tree loses its lower branches and concentrates its growth toward the top in order to compete for its share of sunlight. One result is the production of a large volume of knot-free straight-grained wood. As you approach the crest of the hill note the small firs beginning to grow in the road cut along the highway. The open area with an abundance of sunlight and the presence of bare mineral soil are major attractions for these seedlings.

(.8)

- 28.1 As you approach the intersection with Timmerman Road you will see prune orchards on each side of the highway. These plantings extend eastward along the hillside where tree crops have been the preferred use of the rougher land of Class III capabilities. This crop has had uncertain market conditions in recent years and some of these orchards do not appear prosperous or well kept. The methods of caring for the inter-row area within the orchards are changing. In the past, clean cultivation or mowing were considered desirable to control weeds and increase available moisture. Recently, however, more of the orchardists are using flails, a rotating horizontal drum with short lengths of chain that removes most of the vegetation but does not disturb the soil, thereby preserving moisture without creating conditions that are conducive to soil erosion, an important consideration on these slope lands.

(.3)

- 28.4 As the highway descends into the valley of Gales Creek note the even, straight character of the hillslope beyond the valley. This and the straight northwest to southeast trending valley of Gales Creek are indications of the Gales Creek Fault, a zone of weakness along which past displacements have created the land

form characteristics you are viewing as well as being responsible for some of the local earthquakes. One was felt in Portland in 1962.

(1.0)

- 29.4 As you reach the foot of the grade and negotiate a wide curve to the right you can see the wide flat-floored valley of Gales Creek, similar to much of the terrain you have noted in the Tualatin Basin. This is largely an alluvial surface resulting from the deposition of material the creek has brought down from the eastern slope of the Coast Range. Relatively recent changes in the stream's condition or its base level has caused it to cut below its earlier surface of deposition, a characteristic that will be noted again as you look at the streams flowing down the west side of the Coast Range and onto the Tillamook Delta.

(.3)

- 29.7 Junction with Oregon Highway 8. Just beyond the junction on the left are gravel pits where the alluvial deposits of Gales Creek have been obtained for road building and construction. These are now filled with water and are used for fishing recreation.

As you drive west along the narrowing valley of Gales Creek and begin to ascend the east side of the Coast Range be alert for what may be a considerable volume of truck traffic which will command your attention as a driver and also will give some indication of the region's economic activities. The movement of the logging trucks will be the most complex and difficult to justify on the basis of your knowledge of the location of the major resources, processing centers, and the market. The ownership of the timber, divided between state, federal, and private holdings; the method of sale of the logs or stumpage; and various other considerations result in loaded and empty trucks going in both directions over the highway although probably there will be more logs moving east than west. Another common cargo will be hay, usually baled and largely alfalfa, moving westward toward the dairy farms of Tillamook County. The moist cool summer climate in the coastal area is excellent for the growth of grass but hay does not cure well and does not have the nutritional value of hay raised in dryer areas. A large tonnage is imported from other sections of Oregon such as the Willamette Valley and central Oregon but some is brought from as far as Idaho's Snake River Plain and the Columbia Basin of Washington. The third type of truck that may be seen is the tank truck hauling whole milk. Most of this traffic will be from the west into the urban areas of the Willamette Valley but you may see trucks with full loads of milk bound for the cheese factory in Tillamook from the Willamette Valley.

(1.4)

- 31.1 The "Log Cabin" to the right indicates that you are .2 mile from the next stop.



Fig. 3-A Gales Creek eroding its channel into a resistant rock structure. Most of the work is accomplished during the rainy winter season--principally during periods of flood. (Mile 31.3)

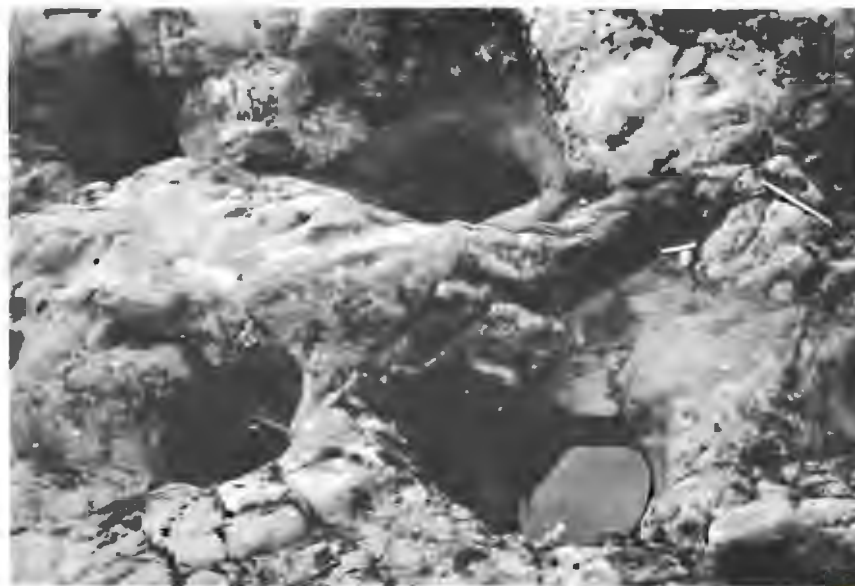


Fig. 3-B Potholes are often found where streams flow over bare rock surfaces with relatively little bed load. Rocks caught in initial irregularities are rotated by the force of running water and the pothole is formed by the grinding action. (Mile 31.3)



31.3 Stop Number Four. Park your car to the right of the highway next to some mailboxes and where a private road enters from the right. Walk down to the incised channel of Gales Creek. For a stream that appears so small during the summer season it has cut an impressive channel into the resistant rock structure. Gales Creek is similar to most western Oregon streams with a great variation between the period of maximum flow during the winter and the period of minimum flow during summer. The erosional capability of a stream is largely determined by its volume during flood periods. The channel of Gales Creek incised into rock is largely the work that the stream has been accomplishing during the winter flood season. This is an interesting area in which to note the work that streams do when they have a rather high gradient, a small amount of material to transport relative to their carrying capacity, and are flowing over bare rock. The potholes in particular are examples of the stream's work under these conditions. They are the cylindrical holes ground into the bare rock surface by the stones that have been trapped in the originally irregular depressions of the channel. A spiraling flow of water in the depression causes the stones to be rotated at the base and the pothole is formed. Other features that can be seen here are also the product of abrasion, such as plunge pools, chutes, and troughs.

It has been indicated earlier that Gales Creek is flowing along the line of a fault and you can see that it is a relatively straight stream with little meandering, indicating that its course may have been influenced by more than chance.

It has been noted that the summer season flow in Gales Creek is greatly reduced. It continues to flow but its capacity to support fish life is lowered. It is usually stocked with fish very early in the spring when the season opens in April. Streams such as Gales Creek flowing down the eastern edge of the Coast Range are fished heavily during the spring. By July or August the water is so low that it is no longer suitable for holding fish and fishing ends until the following spring.

(1.0)

32.3 In this area you are passing several road cuts with exposure of basalt. You are now beyond the westward extension of Columbia River basalt and these exposures represent an older flow considered to be upper Eocene in age. This lava contains a high amount of olivine, a rather unstable mineral that tends to weather quite rapidly.

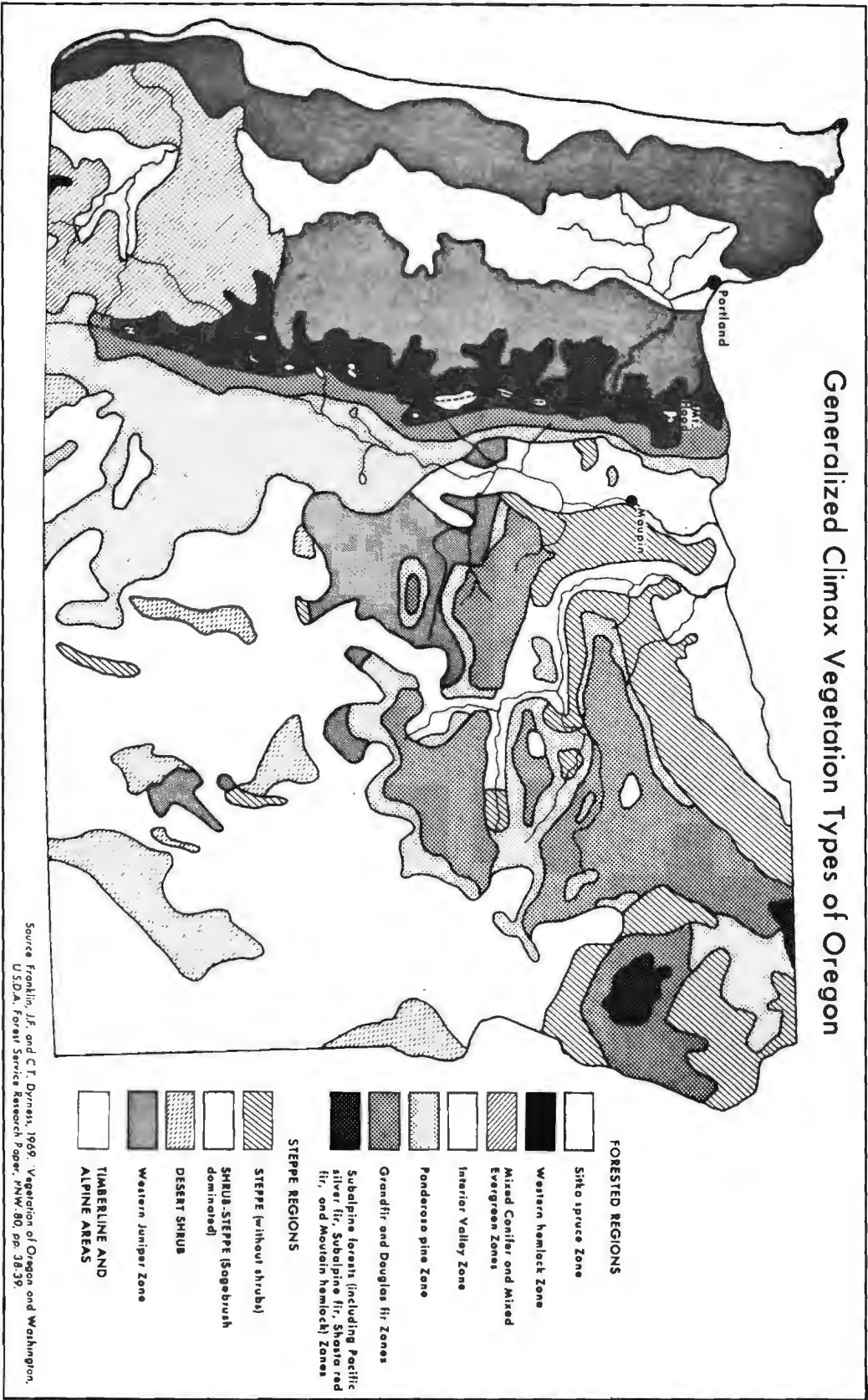
(.7)

33.0 Timber-Vernonia Junction. Continue straight ahead on Oregon 6.

(.3)

33.3 Stop Number Five. Pull over to the right and stop on the broad shoulder of the highway just before the bridge across Gales Creek. At this location you have

Generalized Climax Vegetation Types of Oregon



driven far enough into the eastern slope of the Coast Range to be within the most extensive vegetation zone of Western Oregon and the most important in terms of timber production. This Western hemlock zone is found in both the Coast Range and the western slopes of the Cascades, separated by the Willamette Valley (Plate IV). Although it is called the Western hemlock zone, based on the potential climax species, large areas are dominated by Douglas fir which is the desired species for timber production. Other conifers occurring in this zone are Western red cedar, Western yew, Grand fir, and on the lower western slopes near the coast, Sitka spruce. Deciduous species are not plentiful in old growth stands of this zone but along stream valleys and in areas that have been burned or logged a number of species can be found such as Red alder, Bigleaf maple, Vine maple, Golden chinkapin, Black cottonwood, Oregon ash, and Pacific dogwood. Such shrubs as Kinnikinnick, Oregon grape, Salal, Salmonberry, and Snowberry are common, particularly in shady, moist sites along stream valleys.

Many of these species can be identified at this location and most of the remainder will be noted before the trip through the Coast Range has been completed. Here on the edge of the parking area may be seen Douglas fir, Western hemlock, Western red cedar, Western yew, Bigleaf maple, Pacific dogwood, and Red alder. Across the highway on the slope of the road cut are Salmonberry, Snowberry, and Sword, Maidenhair, and Deer ferns.

(1.1)

#### 34.4 Bridge over Gales Creek and junction to Trolley Park.

(.1)

#### 34.5 You are now far enough into the anticlinal structure of the Coast Range to see the oldest lavas, the Tillamook volcanic series, exposed in the road cuts. These are considered to be either middle or lower Eocene and are interbedded with marine sediments. Many of the lavas are submarine in origin, extruded onto the floor of a shallow sea and badly broken or brecciated. They seldom exhibit the columnar jointing common in Columbia River basalt.

(1.0)

#### 35.5 To the left of the highway is a small quarry with lavas of the Tillamook Series exposed. Note that this exposure does exhibit well developed columnar jointing. When extruded above water where the lava is subjected to the slower cooling of the atmosphere even the Tillamook lavas may develop these cooling or contraction cracks.



Fig. 4-A The combination of heavy rain, steep slopes, and unstable materials create continuing slide problems as can be seen on this section of highway a short distance east of the summit. (Mile 37.3)



Fig. 4-B The first (1933) Tillamook fire began in this area of upper Gales Creek. The regrowth is quite good--conifers are thick and dominant with only scattered deciduous trees. Dead white snags remain as evidence of the fire and a few old living trees can be seen. (Mile 37.4)

(1.7)

- 37.2 The large road cut on the left exposes a broad layer of volcanic sedimentary material. These marine sediments are very clayey, mainly mudstone, and do not stand well on a steep slope. When they become saturated during the winter they begin to move down slopes that have been steepened by the downcutting of streams or by man during road construction. Just beyond this large exposure the highway extends over an area where slides have seriously affected the road bed. The irregular, frequently filled and patched surface and the slipping away of the outer edges of the road are evidences of the problems faced by the highway engineer.

(.2)

- 37.4 Stop Number Six. Pull off to the right and park on the wide turnout section. You have been traveling over a road which is in the process of moving. The bumpy condition is the result of a sliding problem that is a continuing one for the Highway Department. The roadcut across the highway exposes Eocene lavas of the Tillamook Series while other cuts nearby indicate that younger sedimentary rock of post-Tillamook age are also present. The younger sediments resting upon the lava, especially where the slopes are steepened, become very unstable. Slides are normal means of mass wasting and the wholesale downslope movement of the weathered mantle would occur here in these deeply incised valleys of the Coast Range whether or not man was present. However, man's presence has meant an increase in opportunity for sliding. Also, sliding in the presence of man means that he and his structures may be adversely affected. This is the case here with the road in almost constant movement and additional repair required after each wet winter.

If you look out to the right, down and across the valley of Gales Creek, you will see the young second-growth timber situated in the area which was affected by the first of the great Tillamook fires. In fact, it was very close to this point, in the upper drainage of Gales Creek that the first Tillamook fire began on August 14, 1933 when, with a strong east wind, temperatures were high, the humidities very low, and fire danger was extreme. Once started the fire was almost impossible to control. Fire fighting equipment at that time was quite primitive and access roads were almost non-existent. After eleven days the fire had covered 235,000 acres and before it was controlled the total amount of timber killed was almost 12 billion board feet. Fires recurred in this area, which became known as the Tillamook Burn, at six year intervals in 1939, 1945, and 1951. In 1939, fire reburned a major portion of the area and in addition almost a billion board feet of green timber was killed. After the first fire, because 1933 was an exceptional cone year, natural reseeding had occurred on



approximately 175,000 acres. The second fire killed the remaining seed sources, the young trees that had grown since the first fire, and made it impossible for natural reseeding to occur. In 1945, the third fire burned for approximately six weeks, covering 180,000 acres. In 1951, two smaller fires affected 38,000 acres and about 10 million board feet of logs that had been harvested from the earlier burn area, but no green old growth stands were burned.

One of the amazing features of the Tillamook Burn was the amount of salvage accomplished. It was estimated after the first fire that only about four per cent of the total volume of wood had been burned, but after the trees were killed insects and fungi began to work and salvage had to begin immediately to reclaim the timber before it was ruined. Production was at a rate of three to four hundred million board feet annually and continued until a few years ago with at least eight billion board feet of the total 13 billion reclaimed and utilized. This was made possible through the sale of state bonds that financed the salvage operation as well as the replanting and reforestation of the burned region. Although much of this land was originally in private holdings most of it reverted to the individual counties after the fires and later was taken over by the state. The present area of the Tillamook Burn, or more appropriately termed the Tillamook-Clatsop Forest, is in state possession and the State Department of Forestry has been the agency directly concerned with the reforestation project.

Devastating forest fires still occur but the danger is far less than it was during the initial fire of 1933. Laws have been passed to close logging operations in western Oregon when the relative humidity reaches 30% and many companies shut down at 35% to provide a margin of safety. In contrast, it was estimated that the relative humidity at the time of the first fire was only 8%. Conditions in the forest must have been almost tinder-like and the scraping of a cable across a cedar log apparently was responsible for the ignition of the first flame. Methods of fire surveillance have been improved, at first by means of lookout towers and now by aerial observation. Once the fire is spotted the possibilities for control are much better. Methods of getting to the fire are faster, and modern equipment is much more effective.

You can see here, and you will continue to notice as you travel through the remainder of the burned area that although the regrowth has been excellent in some sections, with very good stands of Douglas fir and Western hemlock, there are other areas which have remained essentially bare or which are covered largely with deciduous trees, either maple or alder. These have little economic value and, in addition, act to slow or prevent the regrowth of Douglas fir which requires exposure to sunlight and must have a cleared area which is relatively shade-free.



In these steep slopes of the Coast Range, with many bare rock outcrops and soil which is thin and in the process of downslope movement, there is little possibility of regrowth. The Tillamook Forest looks much better now but regrowth is not complete and it is not anticipated that it will be.

The initial effects of the fire on wildlife were, of course, disastrous. It is difficult to estimate the total number of animals destroyed but with a fire moving rapidly and covering such a large area undoubtedly the loss was enormous. It is interesting to note, however, that in the post-fire years the removal of the thick even growth has been very beneficial for most types of wildlife. This is certainly the case for the game animals such as deer and elk. There were relatively few of these animals when the old timber was growing in the Coast Range. Once the trees were removed through burning and subsequent logging the new growth provided a much better source of food. As a result, hunting in the post-fire years has been much improved. On the other hand, as the young forest reaches a certain age it begins to form a thick stand that precludes the growth of shrubs and grasses. Hunters are apt to blame the Game Commission for poor policy and administration but a reduction in the number of animals has to be expected as the natural carrying capacity is reduced.

(.8)

- 38.2 Above the road to the left is the remnant of a high logging railroad trestle that can be easily seen during the winter but may be largely concealed by the deciduous vegetation during the summer. Early logging in western Oregon was conducted before heavy duty trucks were available and the railroad was the major means of transporting logs to the mills. As trucks became common the rail equipment was replaced and is little used today.

(1.0)

- 39.2 Summit (1568 feet). This very modest summit elevation results from the moderate uplift of the Coast Range combined with the downcutting accomplished by streams in this region of heavy precipitation. You have now left the valley of Gales Creek and will move down into the upper drainage of the Wilson River which the highway will follow to the Tillamook Delta. Although most of the winter precipitation at the summit is rain, even this modest elevation can mean significant temperature contrasts between the adjacent lowlands and the mountain barrier. This may result in periods of heavy snow and hazardous driving conditions with subsequent thawing increasing the possibility of slides into the highway.

(.7)

39.9 Stop Number Seven. Pull over to the large parking area on the left hand side of the highway just before crossing the Devil's Lake Fork bridge. Get out of the car and look over the rugged terrain to the south. We have noted earlier that the Coast Range is a relatively simple, youthful fold with continuing uplift. This location is close to the top of the anticline. With the heavy precipitation, however, the agents of erosion have already cut deeply into this folded structure and created an area of mature dissection with deep valleys and narrow, sharp ridge crests: an area with a maximum of relief. The Coast Range is not high but it does serve as a major interceptor of moisture borne by westerly winds moving in from the Pacific. The orographic influence of the range results in precipitation amounts of 130 to 150 inches a year on these higher western slopes. This is considerably greater than that falling on the eastern slope and the disparity has caused asymmetrical erosion. On the western side streams have cut more deeply and by headward erosion have extended their channels not only to, but actually beyond the crest of the range. This has caused a number of stream captures and important stream derangements. Man has taken advantage of this in some cases by tapping the upper courses of these west-flowing streams and diverting them into the Willamette Valley to the east where water is in critical demand during the summer season. There are proposals for additional diversions, one of which would include diverting the north fork of the Wilson River into the upper channel of Gales Creek. This water would be used for irrigation and domestic supplies during the summer in the Tualatin Basin.

This stop is a good place to consider a situation that will be seen along the route down the western slope of the Coast Range in the valley of the Wilson River. This is the great difference in types of regrowth of the desired coniferous species, mainly Douglas fir and Western hemlock. As you look over the ridges to the south and to the west, you can see that in some areas the conifers have re-established themselves quite well but in other areas there is a preponderance of the deciduous trees, mainly alder mixed with maple, that have delayed and in some cases seriously impaired the probability of regrowth to Douglas fir. The fir does require sunlight for the young trees to grow well and if the deciduous species come back too soon and with too thick a stand the Douglas fir is seriously handicapped. The State Department of Forestry has tried a number of methods to retard or halt the regrowth of the deciduous species. Farther downslope you will see areas where the alder has been killed by spraying to free the fir seedlings and provide sufficient sunlight for optimum growth. One of the strongest arguments in support of clearcutting is that the Douglas fir is not the climax species for the environment in which it is found in the Pacific Northwest. If left undisturbed the forest would regenerate to deciduous trees and eventually to Western hemlock but the most desirable species, Douglas fir, would disappear. This has not occurred because fires have swept through the forest periodically, reducing the cover and allowing young fir seedlings to grow in sunlight. Clearcutting performs the same

function and it appears that it is the only practical means at this stage in our technology for harvesting old-growth stands of Douglas fir. There are, however, as is the case with most techniques, good and bad practices in relation to clear-cutting and you will see both as you move down the valley to the coast. Under normal circumstances, fir seedlings usually will have a chance to regenerate during the cleared period resulting either from fire or clearcutting. Although deciduous trees may get an early start the fir seedlings eventually begin to push their way through and above the level of the alder and maple. The deciduous trees are usually rather shortlived and their wood is of little value. On the other hand, Douglas fir will live to four to five hundred years, the age of many of the old growth stands that are being cut in Oregon at the present time.

(.4)

#### 40.3 Rest area on the right.

(.3)

40.6 Stop Number Eight. Turn right onto the gravel road that follows the old route of the highway. Drive to a position behind the large rock which has been left standing between the old curve and the new stretch of highway. Walk over to the edge of the Wilson River canyon. A short distance upstream to the east you can see the junction of Drift Creek and the Devil's Lake Fork of the Wilson River from the south. Note that both channels are deeply incised. If you turn and look downstream you will see that the Wilson River is cutting into the Coast Range structure but still meandering, swinging from side to side much more than most such deeply entrenched, youthful streams. This may result from rejuvenation which followed a late period of uplift of the Coast Range. The river was meandering in a relatively wide valley and then forced to maintain its swinging course while the renewed downcutting incised the meanders into the narrow valley. You can see that this is not an easy place to construct a highway and yet one of the major uses of youthful streams has been to provide routes for transportation lines through rugged mountain areas that otherwise would prove to be almost impassable. The route is difficult but in many cases the only one available. If you consider the passes through modest elevations of the Coast Range and the more formidable barrier of the Cascades it can be seen that in every case the highway will follow a stream valley to the summit area and then enter the valley of a young stream flowing in the opposite direction.

Look across the valley to the south facing slope opposite your position and note the exposed layers of lava which dip to the northeast. Recent uplift of the Coast Range has caused the change from the former horizontal position in which the lava was first extruded. Note that the vegetation is very sparse on



Fig. 5-A The steep south-facing slope of the Wilson River canyon at Stop 8. The combination of maximum exposure to the summer sun, steep slope with continuing mass movement, and thin rocky soil makes this a very difficult area to reforest. (Mile 40.6)



Fig. 5-B Looking down the narrow Wilson River canyon from Stop 8. The steep south-facing slope on the right is quite bare but the area beyond is well covered with young conifers. Note the area of active sliding above the highway to the left. (Mile 40.6)

the steeper slopes and that the forest regrowth is very incomplete. There is little soil on the steep slope and much of it is in the process of downslope movement. A few deciduous trees of maple and alder can be found in the rather shallow steep valleys but there is very little fir or hemlock. Farther up the hill where the slopes are less steep there is a better growth. Across the Devil's Lake Fork to the east is a better stand of conifers and a few old trees that have provided a source of seed since the early fire. On the high slopes above Drift Creek you can see dead snags that have not been removed and their white weathered forms stand above the surrounding green second growth. In general it has been the policy to remove as many of these snags as possible because they are a fire danger. Lightning striking a snag will cause it to literally explode and shower the surrounding area with live sparks and coals that can start a fire if the forest is dry.

At the bottom of the canyon are some old car bodies and other garbage. Even here near the crest of the Coast Range we are using our natural environment as a dumping ground.

Return to your car and drive to the main highway. Stop and look across the highway to the left at the volcanic rock which is exposed in the road cut. The thin baked zone of reddish color resulted from lava flowing over the weathered surface of an earlier flow, exposing it to the high temperatures of the flowing lava. This baked zone has been displaced by a diagonal fault that is dipping to the east at an angle of 50 to 60 degrees. Also note that the lava is well jointed but does not show columnar jointing as is common with much of the Columbia River basalt that you would see traveling through the Columbia Gorge.

(.7)

- 41.3 A group of older Douglas fir trees can be seen on the slope across the river. It is interesting to note the many small islands of mature trees left within this large area of devastation. These small groups of survivors have been valuable sources of seeds although where successive fires occurred the losses of many young seedlings and the damage to soil has made natural seeding unlikely or impossible.

(.2)

- 41.5 The fence along the left side of the road is designed to protect the highway from sliding material. This will be effective against minor amounts of small debris but will not prevent larger masses from covering the highway.

(1.5)

- 43.0 Stop Number Nine. Pull over to the left and park at the abandoned rest area. Walk over to the waterfall where the stream is forced to descend over the



Fig. 6-A The small stream is falling over a layer of resistant lava. The damage to the picnic area occurred during a winter flood period when the stream's volume was much greater than at present. (Mile 43.0)



Fig. 6-B The rock face exposed at the extreme right of the upper photograph exhibits some very intricate weathering patterns. Note the spheroidal weathering and the thin layers that are separating from the mass. (Mile 43.0)

resistant lava protecting the weaker sediments, mainly shale, beneath. Note the great amount of material that was brought down during flooding in the winter of 1971-72. This is a good illustration of the great disparity of flow between the dry summer and wet winter. Not only has a great deal of fine material been deposited by the rampaging stream but the picnic area has been covered and ruined. Picnic tables are at odd angles and partially buried and there are large logs that have been deposited by the stream.

This area exhibits a rather complex assortment of rock types: the lava in the location of the water falls and the dark horizontally bedded shales to the west of the waterfall that contain a number of small fossils. There is also a suggestion of a fault that can be seen by the alinement of the tributary stream to the north of the Wilson River and the small stream here.

(.4)

- 43.4 You are entering a major slide area in the very narrow canyon of the Wilson River. Slides have closed the highway several times in recent years. In addition to building the protecting fence the highway department has removed large amounts of the material most subject to sliding above the road cut. Once the material has been removed its deposition becomes a problem in this narrow canyon. Much of it has been pushed over the lower side of the road and into the channel of the river. This has not been met with overwhelming approval from the game commission or environmentalists.

(1.4)

- 44.8 Looking above the highway at twelve o'clock note the steep rockslide area where the material weathered from the exposed rock face is in the process of downslope movement. The dead snags also emphasize the steep and isolated nature of this ridge since most accessible snags have been removed.

(.5)

- 45.3 On the steep north-facing slope across the river to the left is a fresh scar of a slide that has removed vegetation and exposed the material beneath to continued movements as water flow is concentrated in the narrow trough. Just to the left is the partially healed trough of an earlier slide, indicating that this rapid downslope movement is a common and continuing occurrence.

(.5)

- 45.8 High above the highway at one o'clock are the steep, bare slopes of King Mountain, 3226 feet, one of the higher peaks in this section of the Coast Range. Several lava





Fig. 7-A The steep slope of the Wilson River canyon exposes several lava flows dipping to the north (right). Note the differences in the amount of regrowth and the old trees that survived the fires. (Mile 43.2)



Fig. 7-B One of the most troublesome slide areas along the Wilson River. A fence has been constructed along the inner edge of the highway to prevent rocks from rolling onto the pavement but large masses of material cannot be controlled in this manner. (Mile 43.4)





Fig. 8-A This desolate slope illustrates the fact that regrowth in the burn may never be complete. The bare rock face and the area of active rock fall combine with a southern exposure to form a hostile environment for plant life. (Mile 44-8)

Fig. 8-B The fresh scar on the steep hillside is an area of active and rapid downslope movement. To the left is an older slide partially healed by vegetation. (Mile 45.3)



flows are exposed, rock slides are evident, and a number of white dead snags can be seen. There is almost no forest regeneration. On the south-facing slope in the middle distance there is a modest reproduction of fir and somewhat more maple and vine maple. Contrast this with the heavy stand of alder and fir on the north-facing slope across the valley to the left. Differences in vegetation growth on slopes of contrasting exposure are well known. Despite the heavy winter precipitation, moisture is scarce during the summer. Both slopes receive approximately similar precipitation, but the loss through evaporation is much greater on the south-facing slope where the sun's rays fall more directly on the surface, creating much higher temperatures. The protected north-facing slopes have less sun, more shade, and more moisture available for plants during the summer growing season.

(.4)

- 46.2 As the highway skirts a broad meander curve of the Wilson River, note the large raft of logs that has lodged here during periods of high water. The large bedload of gravel and boulders indicates that the gradient along this stretch of the stream is not as great as in some of the bare rock channeled areas.

(1.7)

- 47.9 Note that the river and highway are leaving the narrow canyon and entering a much wider valley.

(.9)

- 48.8 Lees Camp. The north fork of the Wilson enters the main stream from the north. The major settlement is located off the main highway to the right in the lower valley of the North Fork. The appearance of vegetation here during the summer makes it difficult to realize that this area receives approximately 130 inches of precipitation a year. This was the average recorded when the Glenora weather station was located here from 1892 to 1916. In mid-summer it appears as dry as the Willamette Valley with its 40 to 45 inches of precipitation per year.

(.7)

- 49.5 You have been driving through one of the large islands of forest that was left untouched by the fires. This is a good setting for the picnic area on the right with the stand of large trees and on one of the widest stretches of the Wilson River valley. The picnic area is on a terrace ten to twenty feet above the level of the river and although the stream has cut down through this former level of deposition the gradient is not particularly steep as evidenced by the extensive deposits of gravel and boulders.

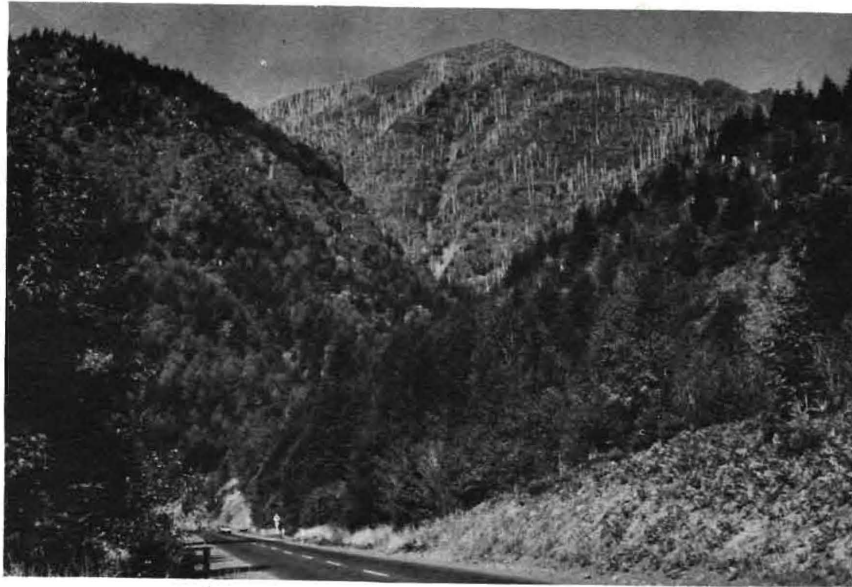
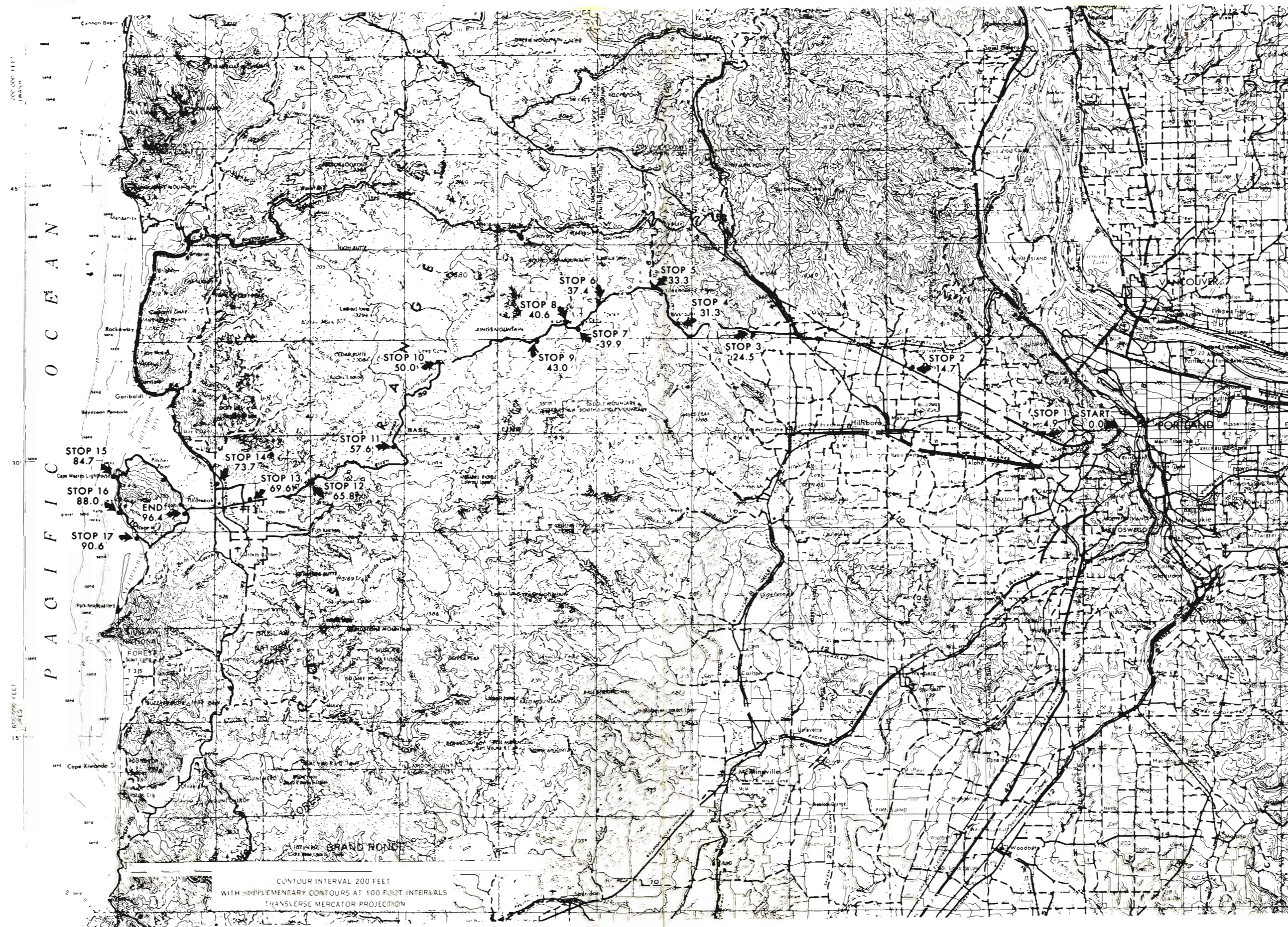


Fig. 9-A King Mountain (3,226 feet) remains almost bare although the large number of dead snags indicate that it was once well forested. (Mile 45.8)



Fig. 9-B The Wilson River has deposited boulders and logs on the downstream portion of a broad meander. More material than water is evident at this time but each winter considerable debris will be transported farther downstream. (Mile 46.2)







(.2)

49.7 Rest area on the right.

(.3)

50.0 Stop Number Ten. Stop in the large parking area on the right. First turn your attention to the outcrop in the cut across the road which shows an interesting contrast between the layered sedimentary rocks exposed to the left and the basalt lava on the right. The line of contact between the two does not show clearly but it appears as if the basalt has been intruded into the weaker sedimentary material. Note also that the river is flowing in a much wider valley, several hundred yards wide, and the slopes are not as steep as you have seen along the valley upstream to the east. The river is incised and flowing in a rock channel about 15 to 20 feet below the general valley floor. The existence of the weaker sedimentary rock as seen in the road cut may be an important factor here and will be noticeable as you proceed down valley.

Walk down to the river and notice how high above the present water level are the recently deposited boulders of considerable size, evidence of work accomplished by the stream during floods. The rock is well jointed and the river is cutting through a rather resistant rock section. There is a small dike-like feature at an angle to the river that indicates a section of more resistant rock located between two formations of weaker material that has been eroded more easily by stream action.

(1.5)

51.5 At this point the river has left the relatively wide valley and is entering a steep narrow gorge. This is the approximate site of a power dam that was proposed in a study made by the U.S. Geological Survey of 1962. The river has cut deeply into the lavas of the Tillamook Series and this narrow gorge combined with the wide valley immediately upstream make it a favored site for a power dam that would have a proposed capacity of 51,000 kilowatts. The dam could be constructed to the 1,000 foot level which would inundate the valley for approximately five miles upstream and require the relocation of the highway. It appears unlikely at this time that the dam will be constructed but the fact that the study was made illustrates some of the basic physical characteristics of Pacific Northwest hydro-power resources. The Columbia and its major tributaries east of the Cascades furnish the major portion of the power with maximum generating capacity during the time of peak runoff, late spring and early summer when power requirements are low. To provide power during the period of greatest need and lowest capacity it is desirable to develop sites on streams west of the Cascades which have their highest flows during winter. At this site the Wilson has an average stream flow of

1,195 cubic feet per second, but it has varied from a maximum of 30,000 cfs to a minimum of 55 cfs. Over one-half of the runoff occurs from December through February and over three-quarters from November through March. The average for July is 117 cfs; for August, 74 cfs; and September, 102 cfs. The proposed dam would generate power only between November and April, storing excess winter runoff in the reservoir to be released slowly during the summer to bring minimum flow up to 150 cfs which would aid fishing and other recreation during the dry summer season. Many potential power sites have been examined in the Coast Range but while they could furnish additional power during the winter when it is most needed, the cost of such power would be higher than that from the larger projects already constructed. The higher cost combined with increased concern for the environment and current interest in the potential of nuclear plants makes the construction of these small power plants less likely.

(1.0)

- 52.5 Note the deep narrow gorge the river is cutting in this section. The road cut to the left of the highway exposes a mass of unconsolidated, stream-deposited material with boulders 5 to 6 inches in diameter situated in a matrix of finer sands and gravels.

(.5)

- 53.0 A stand of Black locust trees is growing along the right side of the highway. These trees are not native to this area but have a wide environmental tolerance. They appear to be growing quite well here and can also be seen at early homestead sites in the arid and semi-arid regions of central and eastern Oregon where they were imported to provide some protection from the hot summer sun. After the Tillamook fires the burned area became the site of many experimental plantings with trees that were not native to the region. Several of these can be seen along the Wilson River and the Sunset Highway to the north has a strange assortment of exotics that could prove to be very puzzling to a person unaware of the situation.

(1.3)

- 54.3 The river has emerged from its narrow gorge and as it makes a right angle turn and begins to flow south the valley widens and the slopes are less steep. The river is flowing thirty to fifty feet below the major terrace level upon which fields and a few buildings are situated.

(.2)

- 54.5 Bridge over Jordan Creek.



Fig. 10-A Emerging from a narrow gorge the river has eroded a wider valley and developed a broad terrace in this section just above the Jordan Creek bridge. (Mile 54.3)



Fig. 10-B At Stop 11 the river is cutting through a structure of columnar basalt which can be seen in cross section on the opposite side, and from above on this side of the river. The logs perched on the rock are no longer there--they were removed by floods the following winter. (Mile 57.6)

(3.1)

57.6 Stop Number Eleven. Just beyond the Mile 15 marker is a turn-out to the right of the road with ample space for parking. Here the river is cutting through a resistant layer of columnar basalt. The stream has incised itself into this resistant material but you will notice that it still has a very meandering course. As you walk down to the river and over the exposed basalt notice the complexities of the columnar jointing as seen from the several angles provided by the cutting action of the stream. This is an excellent area to observe potholes of varying sizes as well as a general polishing by the stream. The finer material which is carried in suspension provides the cutting tools and the stream furnishes the power for the polishing and abrasion. Note how high above the present level of the stream this abrasive work has occurred. This indicates again the great disparity between summer and winter flow and the extreme situation when flooding occurs during the winter season. Just downstream the river is flowing in a gravel and boulder base. The resistant basalt upon which you are standing has slowed the downcutting and the bare rock channel is the section where active abrading is occurring. Immediately downstream the stream has downcut more easily in softer material, the gradient has been reduced, and the stream is aggrading.

(1.3)

58.9 After flowing south and southeast the river has made a sharp turn and is now flowing almost due west around a large lava flow from the northwest. The vegetation at this point is largely unaffected by the Tillamook fires and this will be the case for the remainder of the distance to the Tillamook Delta although in the higher area to the north the fire burned several miles farther westward.

(.8)

59.7 The highway is running almost due west and has been constructed on an almost level terrace standing considerably above the eroding river.

(1.3)

61.0 The valley is now becoming wider as the highway crosses the river which is meandering to the south. You can see several houses surrounded by fields that have been planted to pasture.

(1.9)

62.9 Spruce trees are becoming numerous along the highway, an indication that you are entering the fog belt. Although summer rain increases as you approach the coast the major difference that allows the growth of the moisture-loving spruce may well be the greater frequency of fogs extending over this area from the west.





Fig. 11-A This large mass of debris was carried down the small tributary valley by flood waters in the winter of 1971-72. (Mile 64.1)



Fig. 11-B A large bar of coarse sands and gravels deposited as Wilson River floodwaters reached the edge of the Tillamook Delta. (Mile 67.5)

(1.2)

- 64.1 Note the flood damage to the house on the right where the small stream overflowed its channel during the heavy rains in the winter of 1971-72.

(1.7)

- 65.8 Stop Number Twelve. There is a parking turn-out to the left just prior to crossing the small bridge. This is the location of a major mudflow that moved down the steep channel and into the Wilson River during a period of heavy precipitation in the winter of 1964-65. The mudflow contained enough material to dam the river during flood and the water backed upstream for a considerable distance. This caused considerable concern downstream. If the dam had broken suddenly the water rushing down the Wilson could have caused serious damage in the lower river and onto the Tillamook Delta. This did not occur, however, and the river worked its way slowly through the debris and damage was minimal except in the immediate area. The effects of the damming and creation of the reservoir behind the dam are still apparent. There is a large amount of debris that the river has not been able to move downstream. Above the dam a considerable amount of material still remains from the deposition in the temporary reservoir.

(.9)

- 66.7 Bridge over the Wilson River. Downstream to the right is a sand and gravel reclaiming operation. As the river approaches the delta flood plain its gradient is reduced, its load carrying capacity lessened and the beginning of extensive aggrading is evident. You have followed the Wilson down the west side of the Coast Range for most of its length, and have observed the results of its vigorous downcutting. The Devil's Lake Fork just west of the summit begins at 1680 feet and drops 840 feet in the ten miles before it joins the South Fork. The Wilson from that junction (33 miles to the bay) descends 840 feet, with a 660 foot drop in the first 15 miles. This indicates the basic reason for the greatest evidence of vigorous downcutting in the upper valley and increasing amounts of coarse alluvial deposits in the last few miles. As you enter the delta, the deposits become finer sands and silts, material that can be most easily transported by the subdued stream. Even here, however, the Wilson and its neighbors have occasional flings of youthful vigor during floods. Sand and gravel bars clogging channels downstream on the delta flood plain have resulted from the major flood in 1972.

Looking across the river to the right you can see the terrace standing above the present river level. This terrace extends downstream and merges with the delta and represents a former higher level of river deposition.



Fig. 12-A Dairy cows on the Tillamook Delta. Holsteins, the large black and white breed, are the most numerous but the tan, brown, and cream colored Guernseys and the Jerseys, grey and brown with black muzzles and hoofs, are also common. (Mile 70-4)



Fig. 12-B Dairy barns, shelters, and the cylindrical silos are well constructed to withstand the wet and often windy winters. Silos are used for the storage of feed since winter grass has little nutritional value. (Mile 70-4)

(1.2)

67.9 You are now entering the eastern edge of the Tillamook Delta. The town of Tillamook is directly ahead at twelve o'clock and beyond it rises the timbered ridge that stands between Tillamook Bay and the Ocean. The Wilson River hugs the northern edge of the delta as it flows toward the bay although in the past it has wandered widely in its delta building activities, sharing these duties with the Trask River which flows in an approximately parallel course about two miles to the south.

(1.7)

69.6 Stop Number Thirteen. Pull over to the right and stop just beyond the Highway Department weighing station. You are now well within the Tillamook Delta. This is a broad alluvial plain which has been formed by deltas deposited by the five rivers that enter Tillamook Bay: the Tillamook and Trask Rivers to the south, the Wilson, the Kilchis and Miami Rivers to the north. These streams have flowed from the Coast Range with high gradients, carrying large loads of gravel and finer materials and have extended their deltas into the eastern and southern portions of the Bay, eventually forming the alluvial plain upon which you are situated. The plain is low, with a rather level surface but it is not flat or all at the same elevation. Streams which earlier deposited their material have cut down into the alluvial plain following either a lowering of sea level or an uplift of the Coast Range. As a result these streams are flowing at a level below the flood plain and have formed extensive terraces. Across the highway there is a higher terrace upon which much of the residential area of Tillamook has been constructed. This terrace, situated between the valleys of the Wilson and Trask, is high enough to protect most of the city from modern floods.

North of the highway are dairy farms with most of the land in pasture and a number of large barns and other out-buildings indicating the major agricultural endeavor in Tillamook County. The combination of arable alluvial soils, the level topography and the moderate marine climate which provides a long period of cool but not cold weather has proved to be almost ideal for dairying. Tillamook County is the most important dairying region in the state. The industry began approximately one hundred years ago when a group of German-Swiss settled on the delta and began doing what they knew best--producing high quality milk and cheese. The poor transportation facilities during the early years made cheese the logical export commodity. The dairying industry in Tillamook County grew rapidly during the early years of the 20th century but has shown relatively little change in the past twenty years. The number of cows in the milking herd has remained at about 18,000 although there has been an increase in total output as the production per cow has increased. There also has been a considerable reduction in the number of farm units with improvement of methods and the introduction of new milking and other equipment that has made larger

herds possible and perhaps necessary. The land in farms for the county as a whole is less than 70,000 acres or approximately 9% of the total, and slightly over 70% of the land in farms is used for pasture or harvested crops. Dairy farms dominate the agricultural economy accounting for over 60% of the county farms. Because of the emphasis on dairy farming the type of crops grown tend to reflect forage needs, and of the 8,000 acres of cropland harvested approximately 77% is for hay crops. The extensive use of the land for pasture, about 60% of the land in farms, is also characteristic of Tillamook County agriculture. More than 86% of the gross sale from agriculture is from dairy farms.

The climate which is so favorable for dairying is a typical West Coast Marine, with average precipitation over 93 inches, eighty-four per cent occurring during the seven month period from October to May. However, even the driest month has an average of about 3 inches. The warmest month is July with an average temperature of 59 degrees while the coldest is January with an average temperature of 42.5 degrees. The growing season is approximately 200 days, considerably shorter than many coastal stations (Astoria - 261 days), and perhaps due to the enclosed basin characteristics of the delta creating temperature inversions with later spring and earlier fall frosts.

(.8)

70.4 Junction with the Wilson River Loop Road. Turn right onto the Loop Road. This will take you through an area that is almost exclusively in dairy farms. Farmsteads with large barns and other outbuildings are scattered over the green landscape of improved pasture extending from the highway to the bridge over the Wilson River. Most of these farmsteads are situated above the lower flood plain but the pastures within approximately one quarter mile of the river are flooded.

(1.2)

71.6 Bridge over the Wilson River. Cross the bridge and turn left approximately one-tenth of a mile beyond the bridge. (If the bridge is closed take detour to the left, proceed 1.9 miles to Highway 101. Turn right, drive .8 mile, turn right into the cheese factory lot and continue with the guide on page 53, mile 73.7.)

(.5)

72.1 Notice the interesting pattern of stream deposited material in the road cuts to the right. The material in the individual layers are relatively well sorted according to size but there is a considerable variation from layer to layer, indicating the changing ability of the stream to transport material to this location. The larger the size, the greater the carrying capacity of the stream, perhaps an indication of the severity of earlier floods.

(.1)

72.2 The near bank of the Wilson River to the left has been modified by a project of channelization conducted by the Soil Conservation Service with cooperation from the Oregon Game Commission and the Army Engineers. Channelization is often regarded as an evil practise but this project, conducted on several of the Tillamook Delta streams, is based on sound conservational principles. The banks of these streams within the delta consist of fine, easily eroded silt. When the stream undercuts its banks on the outer edge of a meander two main types of damage result. First, the farmer may, over a short period, lose several acres of good agricultural land, and secondly, the stream transports the newly acquired load to the bay, already badly silted from this type of action.

Carefully rounding the bank by removing the upper portion and then placing a cover of large rocks upon the new slope provides protection that it is hoped will aid in the preservation of both the land and the bay.

A limited amount of channel modification to provide a more efficient stream flow has been conducted in a few stretches and the removal of several large sand and gravel bars, particularly in the Wilson and Trask, was begun in the summer of 1972 in an attempt to take this material from the streams before it can be transported to the bay.

(.8)

73.0 You are now driving on the higher terrace along the northern edge of the delta flood plain and are well above the area subject to flooding.

(.3)

73.3 Just beyond the railroad crossing is one of the active sawmills in the local area. Many of the smaller mills have found it difficult to obtain a steady supply of logs with so much of the forested area in either large private tracts or in the region affected by the Tillamook fires.

(.3)

73.6 Junction with Highway 101. Turn right.

(.1)

73.7 Stop Number Fourteen. Tillamook Cheese Factory. Turn right into the parking lot and walk into the processing plant where the cheese-making procedures may



Fig. 13-A Channelization along the outside of a meander on the Kilchis River. The rock protects the easily eroded silt banks, preserving farmland and reducing the amount of deposition in Tillamook Bay.



Fig. 13-B A large sand and gravel bar deposited in the lower Trask River during the 1971-72 floods. Some of this material is being removed to improve the channel and to reduce deposition in the bay.

be observed. There are few areas where it is possible to follow each step in the production of a raw material and its manufacture into the finished product, ready for transportation to the consumer, as easily and as clearly as on the Tillamook Delta. You have driven through the pastures growing the basic raw material and you have observed cows engaged in the first stages of processing. On the same farm the second stage, milking, is also conducted and the resulting product, raw milk, is trucked to the factory. Listen to the recorded description of the cheese making process and you will have observed or heard the essential steps in the industry, all occurring within the very limited area of the Tillamook Delta. Originally, the isolation of the region and the slow and infrequent transportation meant that the marketing of dairy products had to be confined to those that would not easily spoil. Cheesemaking was well known to some of the early arrivals and it soon became the chief export product of the dairy industry. Although a considerable and increasing percentage of the milk produced in the area is now shipped to the Willamette Valley as fresh milk, Tillamook remains best known for its cheese. Cheese-making was conducted in many small plants during the early years and it was not until 1969 that the remaining subsidiaries were closed and all processing now occurs in this large modern facility. In 1971 the Tillamook County Creamery Association received over 156 million pounds of milk from its member dairymen of which more than 111 million pounds were used in cheese making. The almost 12 million pounds of cheese produced was marketed throughout the western states with the largest amounts sent to California.

(.1)

73.8 Return to Highway 101, turn left and drive south toward Tillamook.

(.4)

74.2 As you cross the bridge over the Wilson River notice that the banks on each side of the river are higher than the level of the flood plain. These natural levees are well developed features paralleling the channels of many mature streams flowing through a flood plain. They are created by periodic flooding and the deposition of the larger material immediately after the water leaves the current in the channel. Eventually the natural levees will form two narrow ribbons of land rising above the plain.

(.4)

74.6 To the left is the Cornet shopping center representing a northward extension of Tillamook retail facilities. The location is on a portion of the delta that is lower than downtown Tillamook and is subject to modern flooding. With the recent increased concern regarding the use of the lower flood plain it is possible that



the center could not be constructed today. Certainly this area of the delta is one of continuing controversy.

(.4)

- 75.0 The small bridge you are crossing is over Hall Slough, the first of three widely meandering natural drainage-ways that provide a route for the movement of rain and flood waters to the bay.

(.6)

- 75.6 Bridge over Hoquarten Slough. This is the third of the sloughs mentioned above. It was in the lower portion of this channel that ships came into the Port of Tillamook, to the right, during the early days of settlement. The combination of larger ships and silting of the channel has made the port inoperative in recent years.

(.1)

- 75.7 As you approach the stop light get in the right lane and prepare to turn right. You are now in downtown Tillamook, a city of approximately 4,000 that has had relatively little growth in recent years. Its economy is based on agriculture, principally dairying, forest products, and more recently, recreation and tourism. The original town site was selected because it was above the level of most flooding but did have access to the bay. As noted previously, Tillamook can no longer be considered as a port but it is served by rail and highway transportation. Dairying has been the most stable element of the economy although it has had its fluctuations. Logging of the surrounding forests and the processing of the raw material has varied considerably in significance because of the great Tillamook fires but with more than 90% of Tillamook County in forest this resource remains the principal source of income. These forest lands are also important for watershed, outdoor recreation, scenic values, wildlife habitat, and botanical and ecological study.

The majority of the county's industrial plants are located east and south of Tillamook Bay. Ten wood products manufacturing plants and the cheese factory are located along the Southern Pacific railway between Garibaldi and the industrial site at the former military air station south of Tillamook. The latter site is regarded by local planners as the logical area for industrial expansion and the feasibility of improving the channel of the Tillamook River to provide barge access to the site from the bay is being studied.

A major activity which has been present for many years but that appears to be on the threshold of considerable growth is the recreation and tourist industry

with a wide range of available attractions ranging from sight-seeing to hunting, fishing, and boating. This industry could be responsible for a large share of the future growth of Tillamook.

Turn right at the stoplight, proceed two blocks, turn left and go two blocks.

(.2)

75.9 Cape Meares-Cape Lookout Highway. Stop and turn right.

(.4)

76.3 The Tillamook Hospital on the right is located on the edge of the terrace overlooking the lower flood plain.

(.2)

76.5 Bridge over the Trask River. As you cross the bridge you enter a portion of the lower flood plain that is protected from most flooding by dikes. The Stillwell Drainage District combines protection by diking with a drainage system to keep excess water from the land between the Trask and Tillamook Rivers and north to the edge of Tillamook Bay.

(.8)

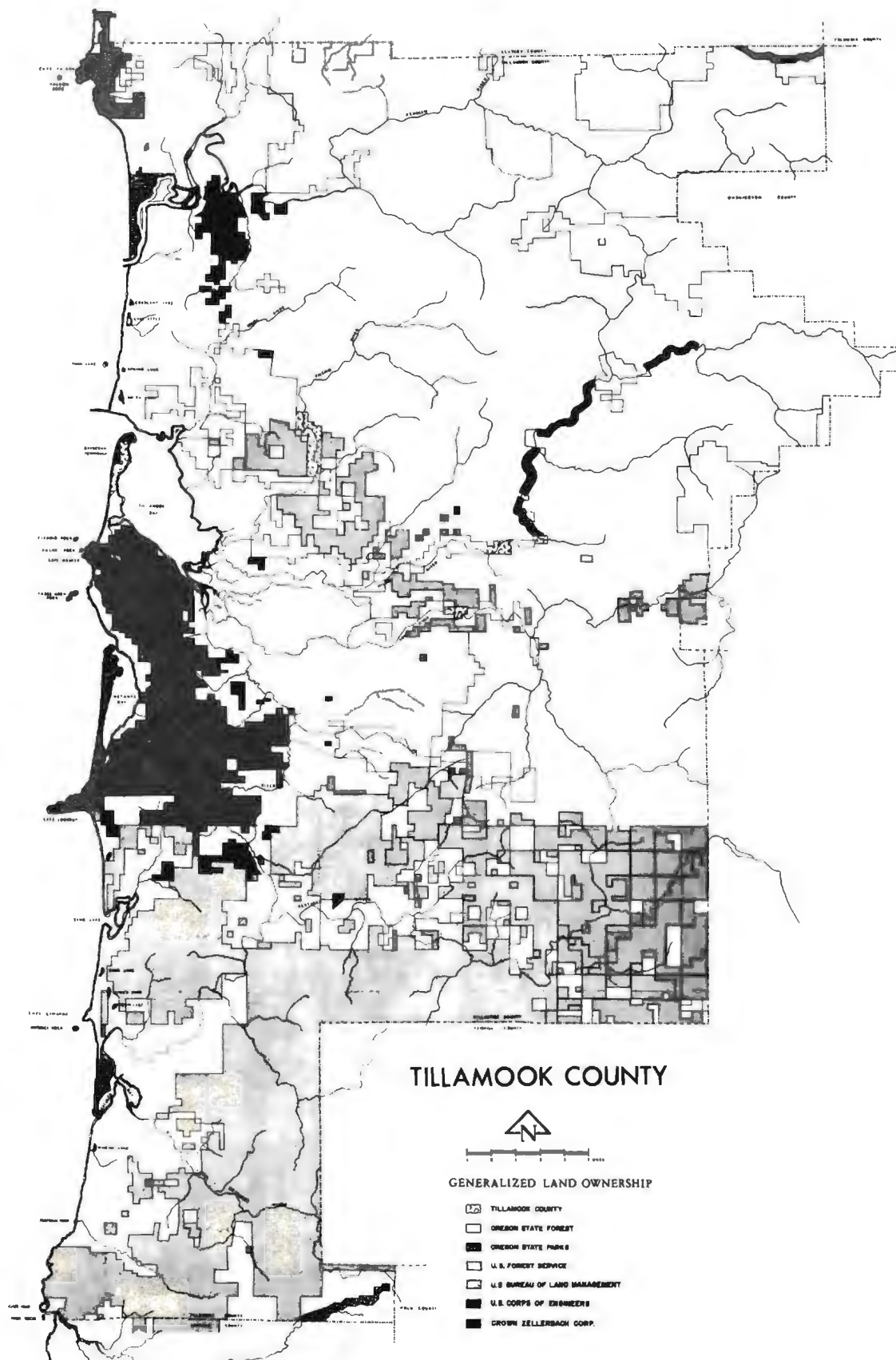
77.3 As you cross the Tillamook River notice the dikes constructed along the banks of the river.

(.3)

77.6 Cape Meares Junction. Turn right onto the Cape Meares road that will take you along the west shore of Tillamook Bay. Shortly after the turn note the old saw-mill on the left, probably in use when the old growth spruce and hemlock were being logged in the area.

(.9)

78.5 As you travel along the western edge of the lowland note the sharp division between the alluvial plain and the steep slopes of the upland to the west and the resulting contrast in land use. The timbered slopes of the upland include areas that have been clear cut within the last few years. Most of the upland between the bay and the ocean is in timber and is a portion of the large private



holdings of Crown Zellerbach. Any consideration of resource conservation or utilization in Tillamook County must take into account the pattern of land ownership (Plate VI). Almost two-thirds of the county is publicly owned with 150,000 acres, or 21%, federally administered, largely under the U.S. Forest Service and Bureau of Land Management control; and 317,550 acres, or 44.5%, are state owned or managed. More than half of the one-third in private ownership is in large tracts such as this, owned principally by Crown Zellerbach and Publisher's Paper Company. This leaves only about 15% for small private holdings upon which the agricultural and recreational developments must be based. It is estimated that private merchantable timber holdings in the county contain 1.2 billion board feet consisting largely of Western hemlock and Douglas fir. State forest lands, principally the Tillamook Forest, are estimated to have 731 million board feet. It is expected that the state land's volume will increase rapidly in the next thirty to forty years as the second growth stands of the Tillamook Forest reach commercial size. The allowable cut on state forest land in Tillamook County is now averaging 36 million board feet a year. It is estimated that by the year 2010 the allowable cut will be increased to 100 million board feet annually.

The logs cut from the Crown Zellerbach holdings in this area are sold on the open market and with the complex pattern of log movement may have destinations ranging from Astoria to Newport on the coast and inland to Willamette Valley plants from Dallas to Gresham.

(.4)

78.9 As you pass the first oyster company plant you begin to get a clear view of Tillamook Bay. With a total of 8,839 acres, 5,140 acres of which is tideland, it is Oregon's second largest estuary (Plate VII). Despite the 400 miles of coastline the state has only about 56,000 acres of estuaries, less than 1/10th of one percent of the area of the state. Only three coastal states in the nation have a smaller acreage of this valuable coastal feature. Formed by the changing relationship of the land to sea level, the Oregon estuaries result from the encroachment of the sea into the lower valleys of the coastal streams. The drowned mouths of these streams have been separated from the sea by long-shore currents forming sand deposits, or spits, between the bay and the sea. Estuaries, like lakes, are shortlived features, geologically speaking. Streams with high gradients and capable of carrying large amounts of material as they emerge from the steep topography of the coastal mountains are forced to drop most of their load as they enter the quiet water of the bay. You have traveled along most of the length of the Wilson River and have seen the work that it has accomplished in eroding a deep valley into the Coast Range. As you moved across the alluvial plain of the Tillamook Delta and out of the bay you have seen the deposition of the materials eroded from the mountains. It is only a matter of time until the Wilson and its fellow workers, the Trask, Tillamook, Kilchis, and the Miami succeed in completely



Fig. 14 Two views from approximately the same location looking south along the west shore of Tillamook Bay. The fact that over 5,000 of the 8,800 acres are tidelands becomes apparent when the same area is observed at high and low tides. (Mile 82.4)



filling the bay. This is a natural process that would occur without the presence of man. Actions of man may accelerate or slow the siltation process. In the specific case of Tillamook Bay, the Tillamook fires, by exposing thousands of acres of steep land to rapid erosion, and the extensive clearcutting of forests in the watersheds of the five rivers have undoubtedly been major factors in shortening the life of the bay. We have noted that it is during time of severe flood that rivers are able to erode and to carry the greatest amount of material. In like fashion, it is during time of severe flood that estuaries accumulate the greatest amount of material. The last period of such flooding occurred during January 1972, and jammed stream mouths, mutilated many salmon spawning beds, reduced the salt water prism in the bay, killed thousands of clams, devastated the oyster beds, and caused a major shift in ecological zones.

The appearance of the bay changes drastically each day with the ebb and flow of the tide. Tides along the Oregon coast are moderate with an average rise of about seven and one-half feet above the plane of reference which is mean low water. Occasionally the ranges will be greater with a minus tide reaching about two feet below the mean low, a clammer's delight, and a corresponding high tide ten feet above. There are two low and two high tides every 24 hours and 52 minutes. At high tide the bay is filled with water, but at low tide more than one-half of the 8,800 acres is exposed in mud flats. Tillamook Bay is a complex environment of interesting and interdependent plants, animals, fish, and water fowl. These plants and animals live in habitats of differing conditions of salt and fresh water. Most species depend upon a narrow range of food supply, temperature, and salinity. Throughout the bay a definite food chain exists in patterns of interdependencies. Continued siltation of the bay will doubtless bring changes in these patterns. Already the tidal prism, the volume difference between the mean high and low tide, has been reduced. This change in the flushing action of ocean water could adversely effect the ecology of the bay.

Approximately 2,600 acres of the bay have been leased by private operators for the cultivation of oysters although only about 500 acres are currently in production. Presently there are three main commercial shucking houses producing approximately 80,000 pounds of shucked meat in 1968. Normally between 85 to 95 percent of the total oyster production of the state occurs here. Oysters do not propagate naturally in the bay and seed oysters have been imported since the industry began in 1921.

Sports and commercial clamming and crabbing are important activities in the bay; gaper and cockle clams are most abundant, with smaller populations of soft shell, butter, and little necked clams. Salmon and perch fishing is excellent and large populations of widgeon, pintails, canvas backs, and other water fowl use the area during fall and winter. Mammals found in the bay include otter, mink, beaver, muskrat and seal. The bay is also the site for a number of activities



Fig. 15-A A view across Tillamook Bay to Garibaldi and the plywood mill, the largest industrial plant on the bay.



Fig. 15-B The fishing fleet in the boat harbor at Garibaldi. The completion of the south jetty and other channel improvements will make the bay more attractive for recreational and commercial craft.



that may conflict with the biotic resources. Across the Bay at Garibaldi is one of the major wood processing plants in the Tillamook area. The manufacturing processes, the rafting and storage of logs in the lower rivers, the movement of sports and commercial vessels, and the possibility of pollution of the water by industrial, domestic, and animal wastes are problems that must be met if the bay is to retain its value as the habitat for a wide variety of interesting and valuable wildlife.

(.4)

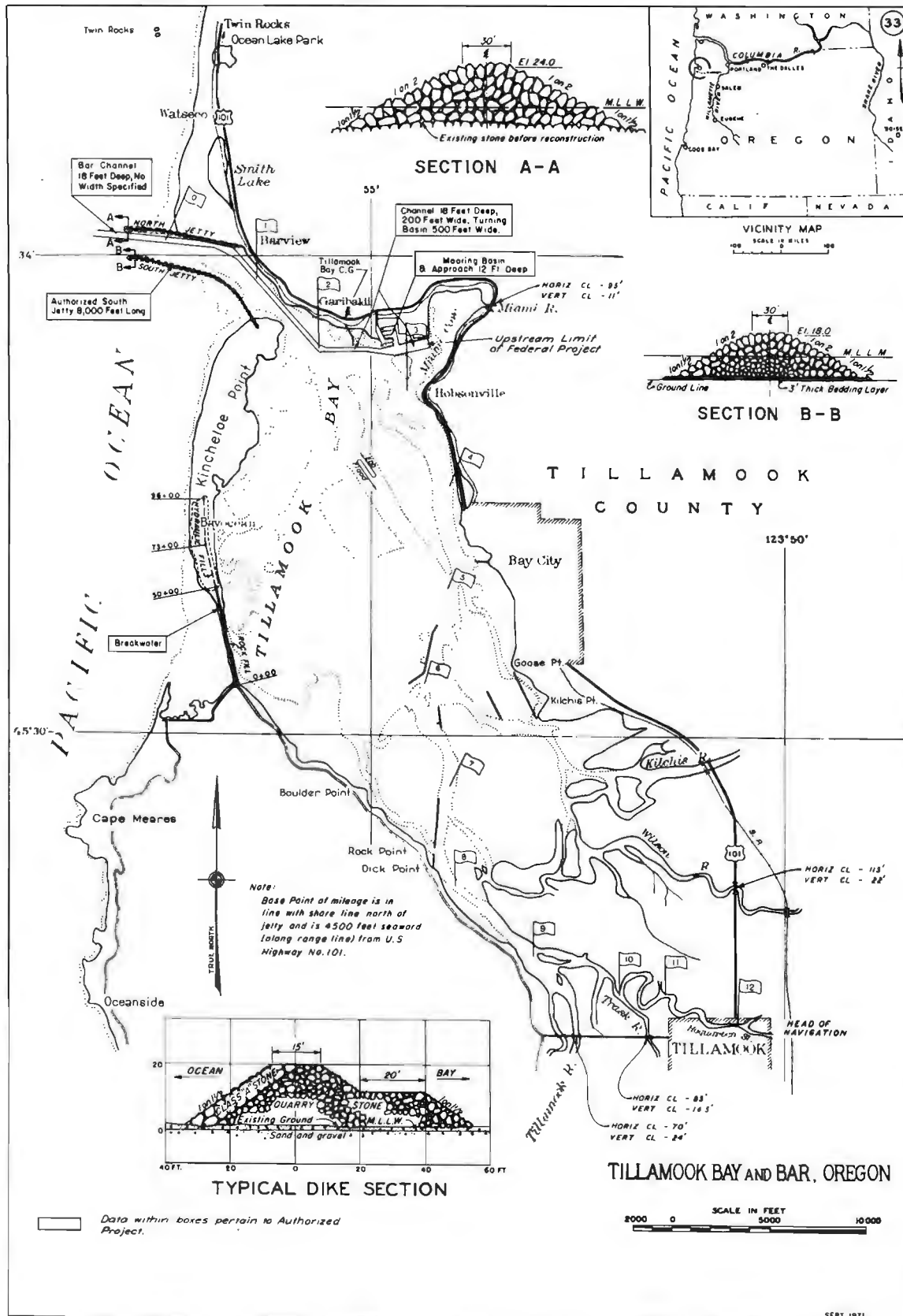
- 79.3 On the left you can see where rock has been placed against the bank to protect the road from slides. Much of the surface in this upland area is subject to sliding, particularly where the natural slope has been steepened by man, stream, or wave action. You will notice several areas where sliding is evident along the road in the next few miles. In some stretches along the edge of the bay the banks to the left are high and almost vertical and consist largely of a rather poorly consolidated sandstone, considered to be upper to middle Miocene in age.

On the bay side there is ample evidence of the 1972 flooding with large amounts of new material deposited along the southern edges of the bay and with many large logs partially exposed in the shallow waters.

(3.4)

- 82.7 At the northern end of the upland is the low sandy Bay Ocean Peninsula, a bay mouth bar extending from its southern end at Pitcher Point northward for four miles and almost completely separating the bay from the ocean. The peninsula was the site of an extensive resort development in the early part of the century. By 1915, more than 1500 lots had been sold and a hotel and natatorium constructed. At that time the bar was considerably higher and trees were growing along almost its entire length. By the 1930s erosion was becoming noticeable along the seaward side and continued until it culminated in 1952 when a storm accompanied by a high tide caused the breaching of the narrow southern part of the peninsula and destroyed all buildings in the development. This mile-wide breach was closed by the Corps of Engineers in 1956 with the construction of a 1.4 mile sand and rock filled dike.

Entry from the sea to the bay is by means of a relatively narrow and shallow channel just beyond the northern end of the peninsula. Conditions over the submarine bar into the bay have been unfavorable for shipping and very few vessels of any size have entered the bay in recent years. The first major attempt to improve the channel was made by the Corps of Engineers in 1917 when the first phase of the jetty on the north side was constructed. This was followed by the second phase in 1933, and a subsequent restoration project in 1967. The construction



of the 5,700 foot jetty is thought by some to be one of the causes for the erosion of the peninsula as ocean currents were shifted. At any rate, the erosion along the seaward side of the southern peninsula has continued with significant changes occurring in the past few years. Between 1969 and 1970 the south jetty was extended 4,200 feet from the northern end of the peninsula. This enclosed a channel 1,200 feet wide with a minimum depth of 18 feet between the two jetties. The original authorized length of the south jetty was 8,000 feet but it is not certain how much of this will be completed. Already the pattern of wave and current deposition is being changed with the addition of several hundred yards of sand along the northern end of the peninsula just south of the south jetty. What the eventual results of these new patterns will be is difficult to determine but they will mark a new phase in the history of the Bay Ocean Peninsula. In addition, completion of the south jetty and the resulting improvement of navigation may have many implications for Tillamook Bay. There may be potentials for improving the economy of the region but any advantages could be offset by the additional threats to the environment of the bay. Wise planning and administration is essential if the growing demands upon the bay do not result in the extinction of some of its activities and inhabitants.

(.3)

83.0 Lighthouse-Oceanside junction. Turn left onto the road that will take you to Cape Meares State Park and Oceanside.

Notice that from the west side of the dike connecting Bay Ocean Peninsula with Pitcher Point is a quiet body of water known as Lake Meares or Biggs Cove, formed by wave and current action to the west which has closed the area to direct access to the sea.

(.4)

83.4 You are approaching an area where recent and continued sliding has caused considerable difficulty for several years. From here to the entrance of Cape Meares State Park you will notice several areas where the irregular road surface indicates an unstable situation. Just south of the village of Cape Meares, directly west, the sea continues to oversteepen the bank along the shoreline and the resulting instability has progressed inland for a considerable distance and has threatened lots and houses.

(.4)

83.8 You have entered a forest area which still has a large number of mature trees and is a good example of the westernmost of the forest zones of Oregon, the Sitka



Fig. 16-A The Sitka spruce zone with thick forest and dense undergrowth reflecting the relatively moist summers and mild winters--a combination that gives this zone the longest growing season in the northwest. (Mile 83.8)



Fig. 16-B Looking over Sitka spruce at two stacks located off Cape Meares. Seabirds, particularly numerous during spring and early summer, are responsible for the light color of the upper rock. Note the wave-cut terrace just above water level. (Mile 84.7)

Spruce Zone which extends in a narrow band the entire length of the Oregon Coast. It has the mildest climate of any northwestern vegetation zone with moderate temperatures and heavy, well distributed precipitation. Frequent fog and low clouds during the relatively drier summer months maintain humid conditions with fog drip from tree tops adding as much as 26% to the annual precipitation. The coniferous forest in this zone is tall and thick with Sitka spruce, Western hemlock, and Western red cedar predominant, and smaller numbers of Douglas fir and Grand fir. Red alder is the dominant deciduous species and is most often found on disturbed sites where fire or clearcutting has allowed it to take over before the conifers can become established. The humid conditions have produced lush understories in mature forests with a dense growth of shrubs, herbs, mosses, and ferns.

(.3)

84.1 Entrance into Cape Meares State Park. Turn right onto the black-topped road and follow it to the parking lot which is approximately .6 mile from the highway.

(.5)

84.6 Just before arriving at the parking lot you pass through a thick stand of second growth of Sitka spruce. Note the density of the stand and the absence of branches for most of the length of the trunks; another good example of self pruning as the young trees compete for the available sunlight.

(.1)

84.7 Stop Number Fifteen. Cape Meares. Park your car and take the path on the right leading down to the lighthouse. This facility is not in use and, in fact, was not supposed to have been constructed at this site. Through some type of administrative foul-up the site was selected and the construction completed before the mistake was discovered. The cape on which the lighthouse is situated is similar to many along the complex coastline of Oregon. Where the rocks result from volcanic activity and are more resistant to the attack of the sea, the coast is steep and rugged and the headlands or capes extend into the sea. Beyond them are remnants of the former extension of the cape--isolated stacks that attest to the erosive force of the sea. Most of the capes and heads are so rugged that it is impossible to pass along their bases, even at low tide, as the sheer rock walls rise directly from the sea. This results in the isolation of sandy beaches formed by the vigorous attack of waves upon less resistant sedimentary materials and the deposition of large quantities of sand by long-shore currents.



Fig. 17-A The vertical cliff just north of Cape Meares exhibits several basalt flows and is capped with a layer of light-colored sandstone. (Mile 84.7)



Fig. 17-B Stacks extending out to sea just south of Cape Meares. The sea has eroded selectively, cutting through weaker rock to form a number of arches. Cape Lookout is in the distance. (Mile 84.7)

The restless sea moves in many ways for many reasons. Twice a day the sea advances and retreats; this tidal action resulting from the varying attractions of moon and sun. This change is not great along the Oregon Coast but the effect upon shipping, fishing, and upon all life in the shallow margins of the sea is most significant. Waves and currents are much more important as agents of gradation, together being largely responsible for the attack on the coast and the transportation and eventual deposition of materials obtained from these attacks and from streams that bring material down to the sea from the highlands of the interior. Unlike tides, however, the action of waves and currents are inconstant in time and intensity. Just as you have noted that streams accomplish much of their work during the infrequent periods of floods, the sea does much of its work during infrequent, but intense, storms. Huge waves attack the shoreline with much greater force and at a higher level. Longshore currents, resulting from waves striking the shore obliquely, are able to pick up and transport much more material during these occasional storms.

Coastal winds differ greatly in direction and velocity during the year. Summer winds are generally from the west or northwest and are relatively gentle. Waves generated by these winds are not large and the resulting southward flowing longshore current is relatively slow moving, unable to pick up as much material as its winter counterpart. During the winter, storms are much more frequent and intense, with the prevailing wind from the south or southwest. More material is eroded from the shore during the winter and is carried northward by the vigorous longshore current.

The effects of much longer term movement of the sea in relation to the adjoining land is clearly evident. Along the Oregon Coast marine terraces can be seen at various levels, from present sea level where wave action is cutting a shelf-like feature into the rock, to elevations of 1,500 feet. At least two of these wave-cut features can be seen on the rock cliff just north of the cape; one awash at low tide and the other at the top of the vertical face. These marine terraces have resulted from the slow irregular uplift of the Coast Range, the periods of relative stability allowing waves to cut a terrace at that particular level.

In contrast to the relative lowering of the sea with the uplift of the Coast Range, there has been a significant rise in sea level in the past several thousand years and it has been this action that has been largely responsible for the drowning of the lower courses of the coastal rivers to form estuaries such as Tillamook and Netarts bays. During the last great ice age, the Pleistocene, with great sheets of ice covering large portions of North America and Europe, immense quantities of the earth's moisture was frozen and not available for the ocean basins. World-wide, the seas dropped at least 300 feet below their present level and streams developed steeper gradients and higher velocities that enabled them to erode vigorously to a lower base level. As the climate warmed and the glacial meltwaters returned to the seas their level began to rise, a process which is continuing today.





Fig. 18-A     A small picturesque cove between Cape Meares and Oceanside. The Cape Meares lighthouse can be seen on the skyline. (Mile 86.7)



Fig. 18-B     A stand of Sitka spruce with the same characteristics of self-pruning that previously were observed in Douglas fir. The stand has been damaged by wind and the area in the foreground has been harvested. (Mile 87.1)

Fog is a common feature along the Oregon coast and you may be able to see some at the present time; if not where you are standing on the cape it may be noted as a persistent bank at some distance offshore. It can be a serious handicap to sea, air, and even highway traffic. Fog can occur at any time of the year but it is most frequent in July, August, and September. It may extend several hundred miles seaward and may hover offshore or move inland for several miles depending on the several factors of wind direction and velocity, and conditions of onshore temperature and humidity.

While you are at the Cape you may wish to visit the Octopus Tree, a Sitka spruce that has grown a number of large extended limbs in contrast to the normal single stem. It is located south of the parking area and signs will direct you to the path that leads to it.

(.6)

- 85.3 Return to the entrance of the park and the junction with the highway. Turn right and proceed south toward Oceanside.

(.4)

- 85.7 Note the deeply weathered rock exposed in the roadcuts. In this mild, wet climate weathering is rapid and the weathered mantle is deep. Also note the narrow, deep canyon which the road crosses in this location. Streams here are short but they have a high gradient and are well supplied with water through a large portion of the year.

(.3)

- 86.0 A quarry in active use can be seen on the outside of the sharp bend of the highway. Good road material is not easy to obtain along the coast; much of the rock is weak sedimentary material and the lava is deeply weathered. Most quarries are in areas of basaltic lava where the exposure is deep enough to obtain rock below the zone of greatest weathering.

(.7)

- 86.7 Another deep narrow canyon is crossed by the highway at this point. Down to the right is one of the many small, picturesque coves that can be seen along the Oregon coast; an area where the short sandy beach is protected by rugged headlands to the north and south and the water offshore is dotted with isolated stacks.

(.4)



Fig. 19-A      Devastation of second-growth Sitka spruce during a single wind storm in 1970. Netarts Bay and Cape Lookout in the background.



Fig. 19-B      Premature harvesting of second-growth spruce made necessary by the storm. The machine is pulling small logs to the stack on the left.

87.1 On the right is a stand of second growth Sitka spruce that shows the effects of high winds along the coast in recent years. On the higher ridge to the left, on Crown Zellerbach land, severe storms in 1970 and 1971 were responsible for the loss of from 50 to 75 percent of individual stands of spruce and hemlock. While the logs can be salvaged if they are quickly removed, the sustained yield program for a forest must be modified when such a disaster occurs. In addition, the value of the stand is considerably reduced when it must be harvested prematurely.

(.7)

87.8 Stop sign in the village of Oceanside. Stop and turn left and continue toward Netarts.

(.2)

88.0 Stop Number Sixteen. Pull off to the right of the road. Here you can view a stretch of the coast that is quite in contrast to the rugged headland of Cape Meares which you visited earlier. This long stretch of low sandy beach extends from the cliff north of Oceanside to Cape Lookout, the prominent headland to the south. This is typical of the contrasts that occur as streams, waves, and currents react to the differences in resistance of the hard lava and weaker sedimentary materials; the sandy beaches occurring where the weaker materials are exposed or where stream valleys reach the coast. Where currents deposit large amounts of sand, wind is able to pick up and transport the finer fragments farther inland. You will notice that the higher area to the left of the road is a large continuous sand dune and little consolidated rock can be seen in the road cuts. On top of the sand dune and overlooking the sea with a spectacular view is the housing development of Camelot. Apparently the developer never read that one should not build his castle upon sand.

(1.3)

89.3 Since the last stop you have been driving through an area that has alternated between stands of spruce and hemlock in some sections and a thick growth of Lodgepole pine in others. Lodgepole pine is one of the most adaptable of conifers; we can find it here on the coast and at an elevation of 5,000 feet in the Cascades. Its presence often indicates a soils condition that makes the site unfavorable for other species during the summer.

(.2)

89.5 As you round the bend you can see below you to the right, Netarts Bay and the bar that separates it from the ocean. In the background is the imposing headland of Cape Lookout.



Fig. 20-A A portion of the long sandy beach at Oceanside with three stacks off shore. (Mile 88.0)



Fig. 20-B The Netarts spit separating the bay on the left from the open sea. The connecting channel is in the foreground. Cape Lookout in the distance. (Mile 89.5)

(.2)

89.7 Entering the village of Netarts.

(.7)

90.4 Entrance into the Netarts boat landing. Turn right and follow the road to the landing.

(.2)

90.6 Stop Number Seventeen. Drive over to the area of the boat landing and park. From this location you can command a good view of Netarts Bay. Although Netarts Bay has much in common with Tillamook Bay, there are some important differences. It is considerably smaller with 2,460 acres, mostly tidelands. It has no large streams flowing into it and has attracted very little of the commercial and industrial developments that complicate the planning for the conservation of Tillamook Bay. There is increasing recreational use of the bay with sports clamming for gaper, cockle, butter, little necks, and soft shells. Cockle clams are dug commercially and there is sports fishing for salmon, perch, flounder, and crab. The bay also supports sizeable populations of water fowl and shore birds. Oregon State University has an estuary research area of 150 acres near Whiskey Creek, along the southeast shore.

In addition to the rapid siltation of the bay, the major threats of its environment are pollution from septic tanks near Netarts, and the filling of the eastern shore line for highway construction. These problems have not seriously affected the bay as yet and can be controlled with relative ease in the future.

Tillamook Bay with its considerable commercial and industrial development, the improvement of entry into the bay with the construction of the jetties, and the resulting increase of boat and ship traffic presents a complex problem for the most intelligent and best intentioned planning body, and it is clear that any final plan for the bay must be a compromise that allows in some way the continued use by the present activities. This together with a smaller size and largely unspoiled environment may be the most compelling argument for designating Netarts Bay as an estuarine natural area.

(.2)

90.8 As you proceed south along the east shore of the bay you can see the extensive riprapping that has filled the shoreline with large rock as the highway was constructed. The bay will present a varied appearance depending upon the

stage of the tide. At low tide large areas of mud flats will be exposed but at high tide it appears to be an extensive area of water from the inner shore to the edge of the bar forming the west shoreline. You should see a variety of bird life; gulls and water fowl should be numerous and you may see a number of the large, long-legged blue heron standing in shallow water near the shore.

(1.1)

91.9 Junction with Tillamook-Cape Lookout road. Turn left and stop at the stop sign. Turn left and drive toward Tillamook.

(1.3)

93.2 Stop sign at the Netarts-Tillamook road junction. Turn right after the stop and proceed toward Tillamook.

(.3)

93.5 To the right you can see an extensive area that was clearcut several years ago. It is likely that the extensive clearing of the old growth forest from the area sloping toward Netarts Bay has been an important factor in the increased silting that has affected the bay in recent years. It is quite possible that the harvest of this timber would have proceeded along somewhat different lines if it were being done today.

(2.0)

95.5 Just after the right angle turn to the left you can see the Tillamook River to the right, and beyond it, the Trask. Both rivers are flowing through the low alluvial plain of the delta and farther downstream toward the bay we have noted the dikes that protect the Stillwell Drainage District from flooding. Back to the right at 4 o'clock you will note a stand of spruce growing between the two streams. This is an area which is unprotected and through which overflow flood waters from the Trask move in a sheet flood into the channel of the Tillamook.

This section of the lower Tillamook has been used as a log storage area and you may be able to see rafts of logs along the banks of the river.

(.9)

96.4 Junction with road to Bay Ocean and Cape Meares. This is the route which you traveled earlier and indicates that you have completed the circular route west of Tillamook Bay. This marks the end of the field trip. Perhaps you have time to spend on the beach, visit the Tillamook museum, or return to Portland by way of the Sunset Highway.



### III. GLOSSARY

Abrasion:	The removal of bedrock material by the grinding action of particles transported by wind, waves, water, and ice.
Aggradation:	The filling in of low areas with the deposition of material by the active agents of erosion.
Alluvium:	Rock fragments transported by running water and deposited in deltas, flood plains, or alluvial fans.
Anticline:	An upfold of a portion of the earth's crust, deforming stratified rocks into an arch-like structure but leaving the layers essentially unbroken.
Basalt:	A dark-colored, fine textured igneous extrusive rock formed from a basic relatively free-flowing lava.
Bauxite:	The principal ore of aluminum. A hydrous aluminum compound formed by chemical weathering in a warm, moist climate.
Bed Load:	Rock particles, generally too large to be carried in suspension, that are rolled or pushed along the bottom of a stream by the moving water.
Breccia:	A rock composed of a mass of relatively large, angular fragments.
Chernozem:	A black, fertile soil usually developed under a mid-latitude grass vegetation cover.
Climax Species:	An association of plants that represents a relatively long-term equilibrium with respect to its environment.
Clear Cutting:	Method of timber harvesting in which all trees are removed from a designated block. Commonly used in forests west of the Cascades, particularly in old growth, even aged stands of conifers.
Columnar Jointing:	Joints which form hexagonal or polygonal columns in igneous rock as a result of contraction during cooling.
Conifer:	A plant with its seeds in a cone-shaped structure; in the Pacific Northwest usually cone-bearing, needle leafed, evergreen trees such as pine, fir, spruce, and hemlock.
Cordilleran Ice Sheet:	The ice sheet that advanced from the center of accumulation in the mountains of British Columbia during the Pleistocene epoch.

Debris Slide:	Rapid downslope movement of unconsolidated debris in which the mass slides forward and forms an irregular hummocky deposit.
Deciduous Trees:	Trees that shed their leaves during a particular period or season, usually because of low temperature or drought.
Delta:	Sediments deposited as a stream enters a large body of water and its velocity is checked. The material is gradually built up so the surface lies above water level as a low, level plain.
Dike:	A wall-like body of igneous rock filling a vertical fissure or crack in the material of the earth's crust.
Estuary:	A bay at the mouth of a river effected by tidal action and resulting from the rising of sea level in relation to the adjoining land mass.
Exotic Species:	Foreign or imported species. Plants or animals that are not native in an area in which they are now found.
Fault:	A breaking of the earth's crust and the vertical or horizontal displacement of once contiguous materials on either side of the fracture.
Glacial Erratic:	A rock resting upon a surface of unlike bedrock. Transported and deposited by a glacier or by floating blocks of ice in a lake or sea.
Gradation:	The process of wearing down of the higher continental areas by the active agents (water, wind, ice) and the deposition of the resulting rock fragments in lower areas.
Headward Erosion:	Lengthening of a valley at its upper end by gulleying, caused by water flowing into the upper extremity of the stream.
Igneous Rock:	Rock formed by the cooling and solidification of molten material after leaving its source and having moved to or toward the surface.
Intrusive Rocks:	Igneous rocks that have been cooled slowly beneath the surface and consequently have a coarse crystalline texture.
Laterization:	Process forming red, residual soils by atmospheric weathering of rocks, particularly in warm, wet climates. The removal of most soluble materials leaves concentrations of iron and aluminum hydroxides.
Lava:	Molten rock (magma) that is extruded onto the surface of the earth.

Loess:	A non-stratified deposit of fine angular silt transported and deposited by the wind.
Longshore Current:	The current moving close to and essentially parallel to the shore, usually generated by waves breaking at an oblique angle to the shore.
Marine Terrace:	A flat or gently inclined surface along a sea coast representing the work of waves in cutting into the rock along the shore. Subsequent change in relative sea level may result in terrace features being located considerably above present sea level.
Mass Wasting:	The mass movement of unconsolidated material down a slope by the direct action of gravity.
Meander:	A bend in the course of a stream, developed through lateral shifting of its course toward the convex side of the bend. Most common on the flood plains of mature streams.
Orographic Precipitation:	The type occurring when an air mass is cooled as it ascends a mountain slope.
Relative Humidity:	The amount of water vapor in the air compared to what it could hold if it were saturated at the same temperature. Expressed as a ratio or percentage.
Rejuvenation:	The renewal of a stream's downcutting ability following uplift, climatic change, or a change in sea level.
Sandstone:	A sedimentary rock formed by the cementation and compaction of sand-sized particles. Coarser textured than shale.
Sedimentary Rock:	Rock that is composed of fragments deposited in horizontal strata, usually in shallow ocean waters, and consolidated by compaction and cementation.
Shale:	A layered sedimentary rock consisting of fine particles that are mainly of clay size.
Snag:	The main stem of a dead conifer with most branches removed. The upright spar creates a danger to the forest from lightning-caused fires.
Spit:	A sandbar extending from a promontory along a coastline. Often formed by the action of longshore currents.
Stack:	A rock remnant isolated from the coast by the erosive action of the sea.

Stream Terrace:	A flat or gently inclined surface composed of alluvium on a river flood plain standing above the present stream level.
Stumpage:	Timber which is sold as it stands, on the stump, in contrast to the sale of harvested logs.
Sustained Yield:	A management program that attempts to maintain harvesting at the same rate as the growth of the natural resource in order to ensure permanent utilization.
Syncline:	A downfold of the earth's crust in which the layers of rock dip inward from both sides toward the axis.
Temperature Inversion:	When surface air is cooled so that it is colder at ground level than aloft. Opposite from the normal decrease in temperature with increase in elevation.
Weathered Mantle:	Unconsolidated material formed from the bedrock upon which it is resting.
Weathering:	The breakdown of surface rock resulting from the action of atmospheric agents, either by physical or chemical means.

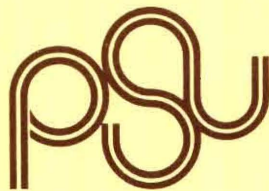
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Geography