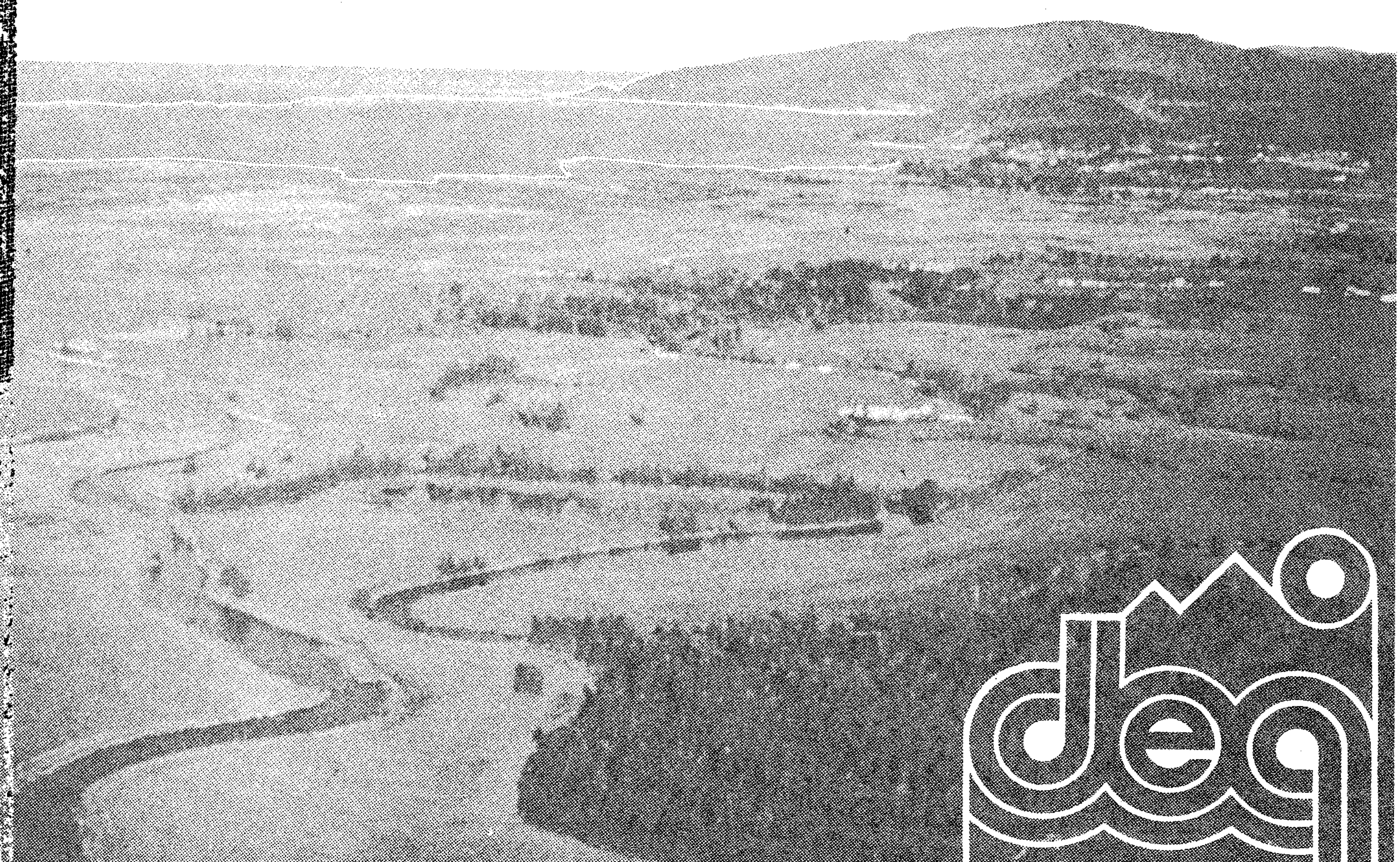
TILLAMOOK BAY

DRAINAGE BASIN WATER QUALITY



State of Oregon
Department of Environmental Quality
Water Quality Program
P.O. Box 1760, Portland, Oregon 97207

TILLAMOOK BAY BACTERIA STUDY

Background Data Review Report

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INTRODUCTION

In recent years, Congress passed the Federal Water Pollution Control Act (P.L. 92-500) and amended it by the Clean Water Act of 1977 (P.L. 95-217). These actions indicate Congressional concern, relayed from its constituents, for the quality of our environment and health of the people. In meeting the goals and objectives of the Act, the Oregon Department of Environmental Quality (DEQ) is involved in a state-wide process designed to identify and correct problems that result from nonpoint source (NPS) pollution.

The DEQ Nonpoint Source Assessment (Rickert and others, 1978) of Oregon, identified critical water quality problems in certain areas of the state including the Tillamook Bay and its associated watershed.

Tillamook Bay has a viable shellfish industry, both commercial and recreational. Water quality impairments due to high bacteria levels in the bay or watershed raise the spector of potential health problems for anyone who comes in contact and ingests with that poor quality water. Shellfish residing in that poor water can become contaminated as they feed on suspended particles containing fecal bacteria and often enteric or intestinal viruses such as those causing infectious hepatitus and gastroenteritis. In so doing, an additional health hazard is realized for persons consuming shellfish that is raw or only partially cooked.

The Oregon Shellfish Sanitation Program and the National Shellfish Sanitation Program are dedicated to protect the public health from contaminated shellfish. The guidelines for these programs require that shellfish must be grown in waters of certain bacterial quality. In conducting this program, U. S. Food and Drug Administration, Oregon State Health Division, and the DEQ have found varying degrees of unsatisfactory bacterial water quality occurring at different times in Tillamook Bay, creating concern about the safe consumption of the shellfish from the bay.

The sources of bacteria have not been confirmed, nor has a plan for controlling these sources been defined. Although in recent years, numerous speculations and suggested abatement measures have been made.

It is because of the inadequacy of the existing knowledge of the problem, confusion as to the causes of the problem, and a lack of firm direction in the Oregon Shellfish Program that the Tillamook Bay Bacteria Study was formulated.

The Tillamook Bay Bacteria Study is directed toward accomplishing five major tasks: (1) reviewing the existing data and information; (2) identifying the problem; (3) conducting additional water sampling as needed; (4) developing a bacteria management plan; and (5) adopting the plan.

This report presents the first part of the study--review of existing data and information. The objective of the review was to determine what is known about the problem and what needs to be done to correct the problem.

To do this, one needs to identify the existing information and then test it against projected needs to correct the problem. This report is presented in the same step-by-step process in which we looked at the existing data. We identified the physical and demographic features of the study area that might effect or might be effected by the problem. We then defined what a bacteria water quality problem was in relation to the study area. All available data and information was located to determine if indeed there was an identified water quality degradation.

This review indicates that there is a problem. The findings of the report show where we have sufficient information, what potential sources must be investigated, and what we have to do to develop and adopt a waste management plan.

DESCRIPTION OF STUDY AREA

Tillamook Bay Drainage Basin

The Tillamook Bay Drainage Basin is located on the North Oregon Coast in northwest Tillamook County approximately 48 miles south of the Columbia River mouth and 60 miles west of Portland (Plate 1). The watershed is 550 square miles (363,520 acres). It is bounded on the east by the crest of the Coast Mountain Range and on the west by the Pacific Ocean. Five major river basins drain 97% of the total land area draining into Tillamook Bay. Four of these rivers, the Tillamook, Trask, Wilson, and Kilchis create an alluvial plain located near the southeast portion of the bay. A fifth river, the Miami, enters the northeast corner of the estuary at Miami Cove through a narrow alluvial plain (Plate 2).

All of the rivers, except the Tillamook, originate on the west slope of the Coast Mountain Range. The Tillamook River begins at the rain shadow side (east side) of the Cape Lookout head land.

The upland areas are characterized by steep slopes with only a small percentage in slopes of less than 20 percent. The lowlands in the basin occur on the alluvial plains of the five rivers, on the fill around the town of Girabaldi and on the remnants of marine and river terraces.

Land uses in the bay drainage basin include 323,050 acres or 90% of the basin in forest occurring in the steep mountainous terrain. The forest land is owned by the State of Oregon (220,840 acres), the federal government (16,400 acres), private timber industries (74,450 acres), and the county and municipalities with 5,860 acres (USDA-SCS, Portland, 1978). Eight Percent (8%) or 29,490 acres of the watersheds draining to the bay are devoted to agriculture, primarily dairy farming. The urbanized areas of the city of Tillamook, Bay City, and Girabaldi and their suburbs occupy 1,730 acres. Miscellaneous nonforested uses occupy 4,220 acres. Water and view related recreation occurs mostly along stream corridors and areas adjoining the bay.

The weather pattern of the Tillamook area is characterized by a strong marine influence with 70% of the precipitation recorded during the months of November through March. Winter storms often result in large amounts of precipitation over short periods of time, resulting in sudden water level changes in the rivers and occasional lowlands flooding. The average rainfall (Figure 1) can be upward of 90 inches along the coast and 150 inches inland to the north-central watershed.

The mean annual water yield for the basin is 2,628,296 acre-feet of water. Approximately 80% of this flows from the Wilson, Trask, and Kilchis rivers (See Table 1).

The average temperature in the Tillamook area in January is 42^{O}F and 58^{O}F in July. Temperature extremes of 0^{O}F and 101^{O}F have occurred. Prevailing winds are generally from the south-southwest during the winter months and

Plate 1. MAP OF OREGON WITH TILLAMOOK BAY DRAINAGE BASIN STUDY AREA.

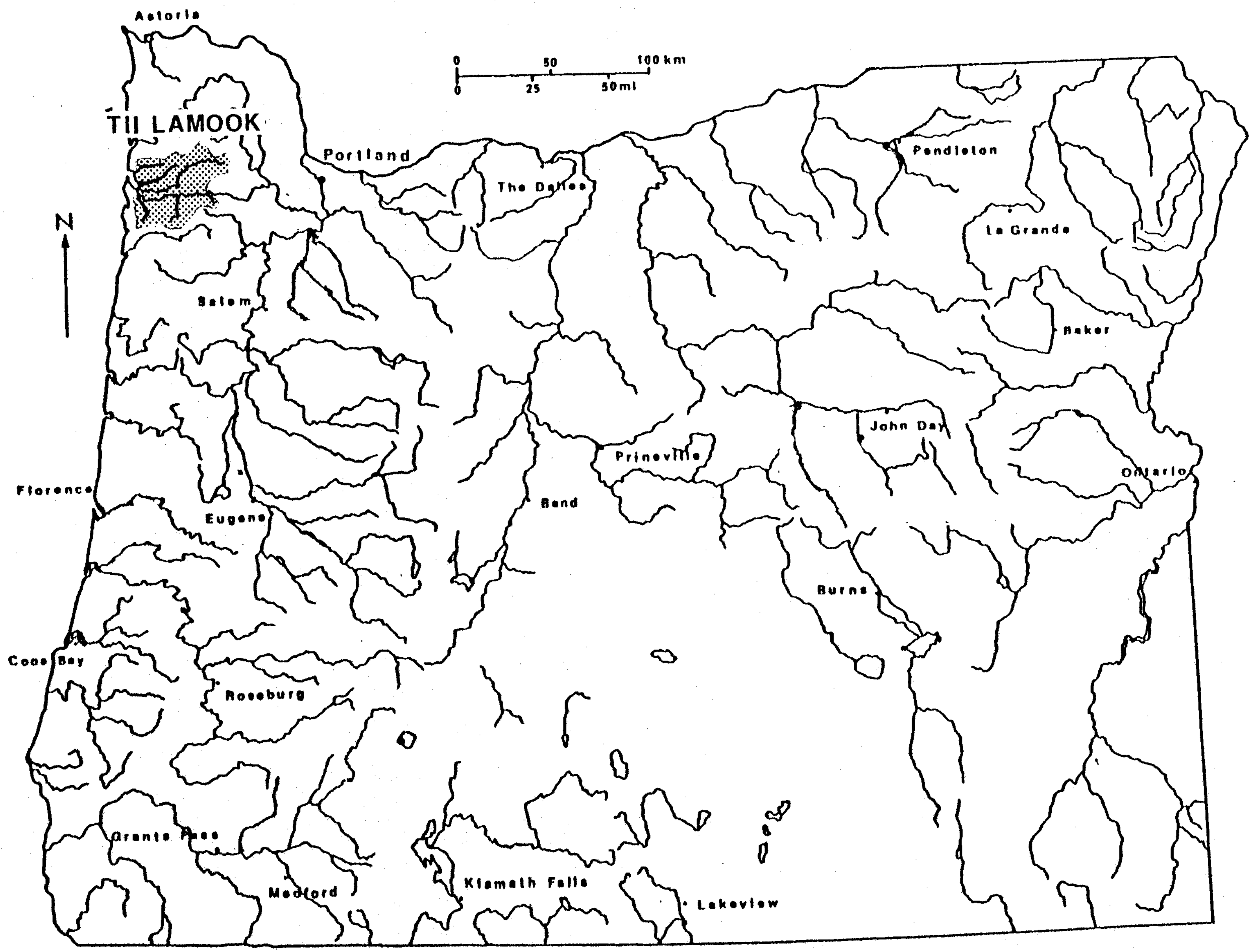
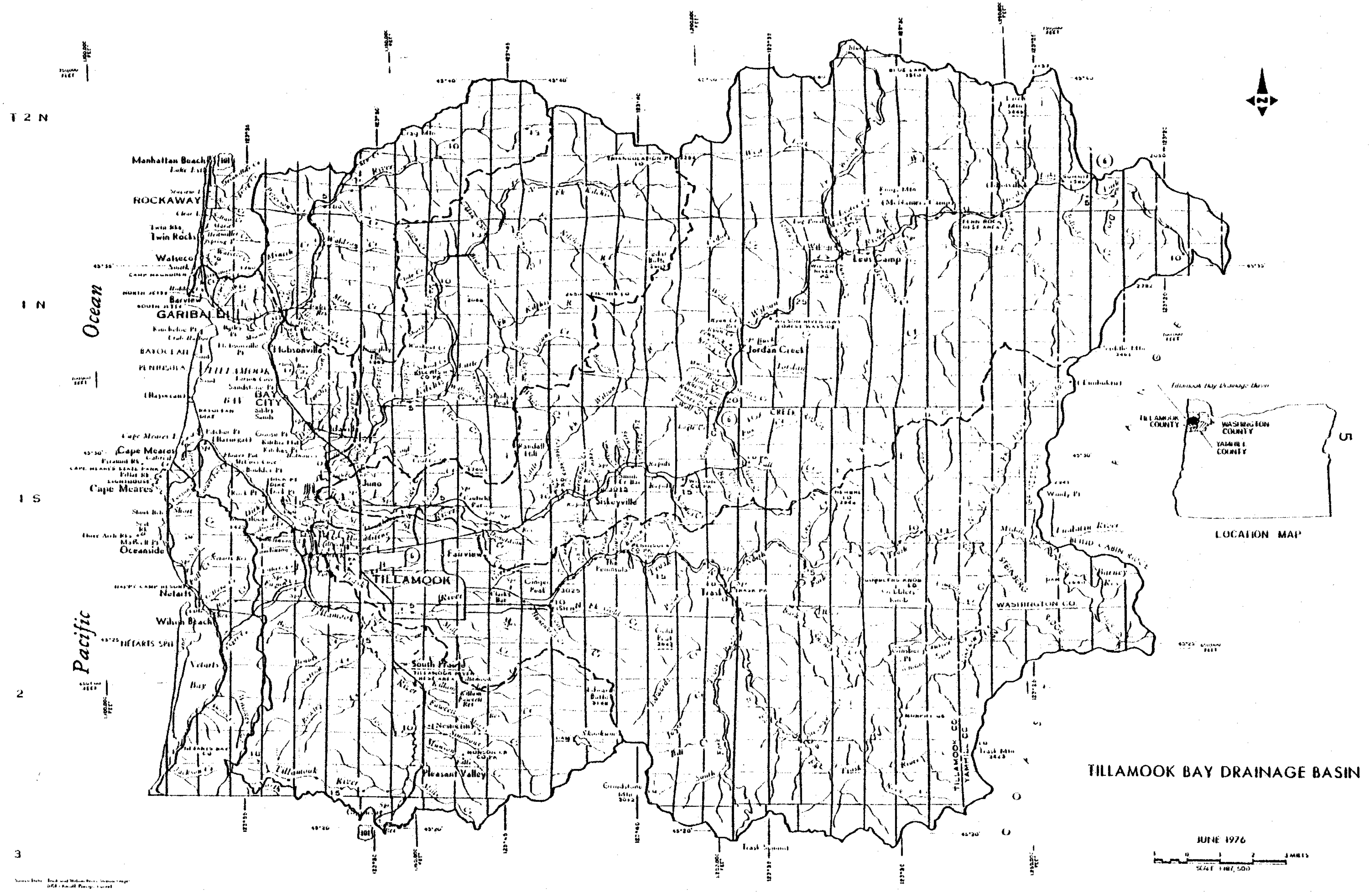


Plate 2. TILLAMOOK BAY DRAINAGE BASIN - USDA-SCS-USFS - MAIN REPORT STUDY AREA MAP.

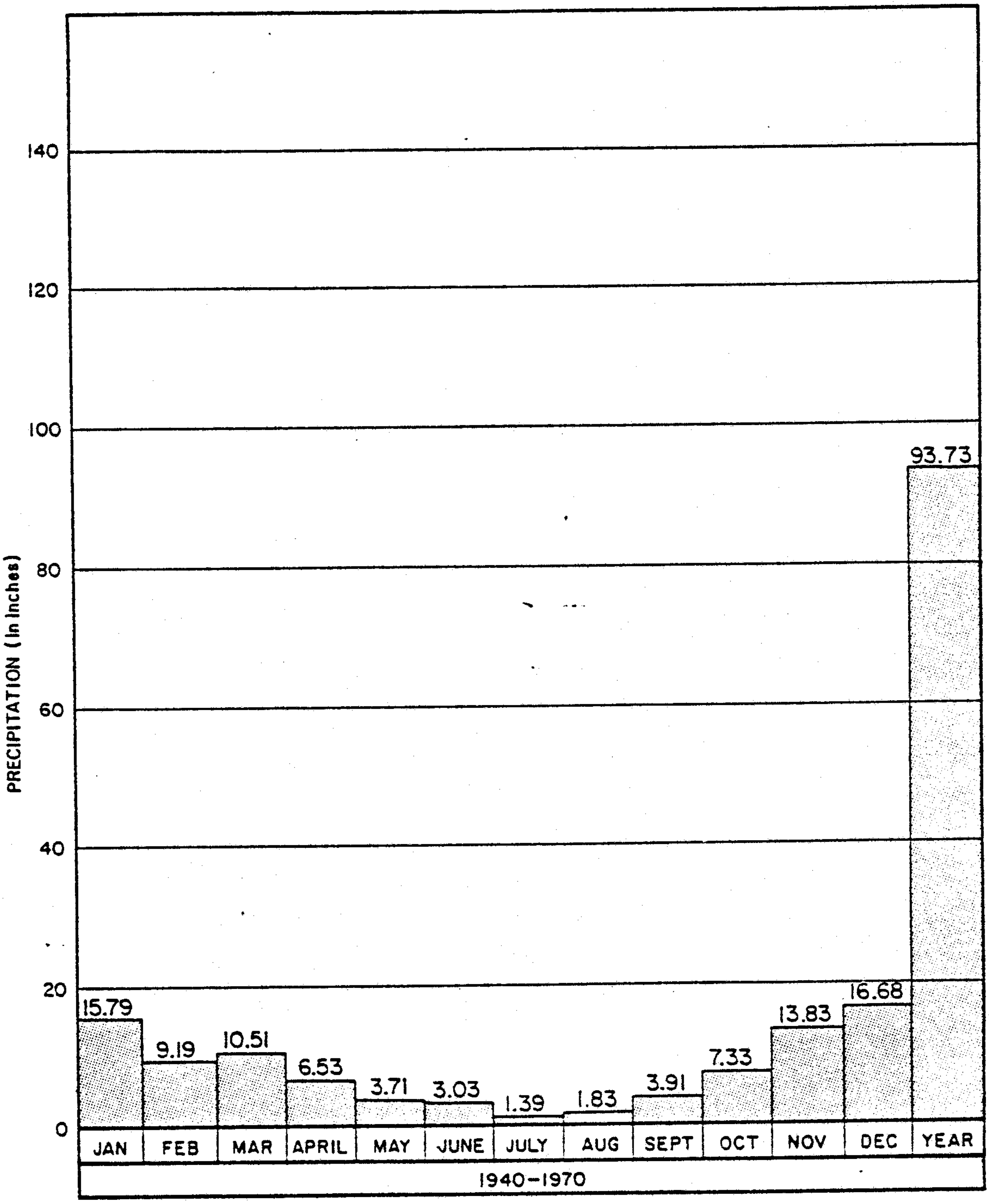


U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

Figure 1.

MEAN ANNUAL PRECIPITATION (1940-70) DISTRIBUTION BY MONTHS AT TILLAMOOK, OREGON

*From Main Report USDA-SCS Figure IV-2.



SOURCE: Climatography of the United States No. 81 (Oregon) NOAA

Table 1 WATER YIELD BY SUBBASIN

Mean Annual River Discharge	Miami	Kilchis	Wilson	Trask	Tillamook
Acre Feet Year	196,263	345,564	1,022,790	811,904	251,775
TOTAL 2,628,296					

Source: USDA-SCS Main Report Table IV-2

TG338 (1)

Table 2.
TILLAMOOK BAY AREA AND DRAINAGE
(Estimated Population Distribution--1980)

	A[1] 1980 Census-Permanent Population Only			B[2] Estimates from Tillamook PUD Files Permanent and Seasonal Population[2]		
	Population	Population On Sewers	Percent Population on Septic Tanks	Population	Population on Sewers	Percent Population on Septic Tanks
A. Direct Discharge to Tillamook Bay						
Cape Mears	120	0	100	593	0	100
Garibaldi	985	950	4	1,200	950	21
Bay City	1,300	1,170	10	1,820	1,170	36
B. Population in Drainage Basins						
Miami	125	0	100	200	0	100
Kilchis	370	0	100	500	0	100
Wilson [3]	1,195	0	100	1,890	0	100
Trask[3]	6,300	4,200	33	5,713	4,200	26
Tillamook	910	0	100	1,098	0	100
C. Total Population	11,305	6,320	44	13,014	6,320	51

NOTES

[1] Population estimate A is taken from the 1980 census counts and is for permanent residents only. The population breakdown to direct discharge and to drainage basins was prepared by DEQ staff. Information provided by the Tillamook County Planning Department and City of Tillamook Planning Department was utilized in the population breakdown.

[2] Population estimate B was provided by the Tillamook Canby Planning Department and is for permanent and seasonal residents. The Planning Department information was gathered from the Tillamook PUD and included locations of electrical meters, counts of electrical meters, and an assumption of 2.5 persons per household.

[3] Population estimate A included Hoquarten Slough in the Trask drainage. Estimate B included the Slough in the Wilson drainage.

TL967 (1)

northwest during the summer months. The basin has a growing season of 190 days without a killing frost.

The population pattern is basically rural. People live primarily on the alluvial plain and terraces adjoining the bay. Concentrations of people are found in the cities of Tillamook, Bay City, Garibaldi and their associated suburbs, and in the unincorporared area of Idaville. Very little shoreline development has occurred on the bay. However, many homes line the rivers and small tributaries inland. Total population in 1980 was 11,305 (Table 2). The 1990 population estimates are 13,480 resident and 14,310 resident plus the recreational population (DEQ, State of Oregon, 1976).

The basic industries of Tillamook County are timber and wood processing, cheese manufacturing and related dairy industry, recreation/tourism, and some seafood processing. The wood products industry accounted for about 43 percent of the county dollar gross output in 1972. The cheese/dairy industry provided about 17 percent of the dollar gross output for the same period. The remaining 40% is divided among transportation, manufacturing, construction, utilities, services, and seafood industry (USDA--SCS, Portland, 1978). Seafood processing made up 1.4% of the county exports in 1973 with oyster aquaculture comprising 0.2% of the county exports (OSU Extension Service, 1977).

The recreational dollar is also very important to Tillamook County's economy. The county provides diversity in water related activities and visual experiences that draw people from outside the county, especially those from the Portland urban area and tourists traveling Oregon's coast along U.S. Highway 101. The recreational dollar estimates range from $47,000,000 (about 35% of the county's economy) (Hempel, 1975) to $12,000,000 (9% of the economy) (OSU Extension Service, 1977). The important point to be made here in the context of this report is that a great influx of people occur in the watershed depending on the weather and/or the season. These people do not have a residence but stay only one day, rent a motel room, or use their own camper or trailer to stay more than one day.

Miami River Subbasin

The Miami River drains 25,550 acres (39.9 sq. miles) of land in the northern portion of the Tillamook Bay watershed (see Plate 2) flows south and enters the northeast end of the bay at Miami Cove.

The main stem Miami River is approximately 13 miles in length reaching into the steep mountainous terrain of the west slope of the Coast Mountain Range. Many small tributaries of one to three miles in length feed the main stem throughout its entire length.

No lakes are found in this subbasin although small ponds of less than one acre in size occur.

Stream gradients in the main river vary from approximately one percent in the narrow flood plains to about 29 percent in the headwater area. Tributary gradients vary from one percent to 30 percent. Tidal influence occurs up to river mile 3.5.

The drainage pattern of the Miami Subbasin has a palmate distribution with an oval shape. Drainage density in the forested portion of the basin is 1.19 miles of stream per square mile. Drainage density in the agriculture lands is 6.64. Some stream meandering occurs in the lower flood plain. The 1/4 to 3/4 mile wide alluvial plain is well drained with few noticeable ditches to carry off surface water to the streams. Minor channel changes with very minimal diking have been made over the years to restrict channel meandering. However, gravel mining in portions of the main river streambed occurs each low flow season between river miles 1 and 5. There are no tide gates to control back flooding of lowlands during high tides.

The Miami Subbasin is judged to have a fair to good hydrologic response. (USDA-SCS, 1978), Note: Hydrologic response is a measure of the land type to orderly dispose of its inherent mean annual precipitation. Some controlling factors are land slope, soil moisture, infiltration rate, vegetative cover, and aspect.) This response is interpreted to mean that the basin has a moderate to high runoff potential with 50 percent of its area in a moderate runoff potential category and 50 percent in the high potential category. A fair category region of the basin occurs only in the steeper headwater areas of the subbasin.

The mean annual discharge from this sub basin, as measured by a State of Oregon Water Resources Department staff gauge located at river mile 1.5 near Moss Creek, is 196,263 acre feet (USDA-SCS, 1978). This is approximately seven percent of the water entering Tillamook Bay. Peak flows of 4,530 cfs during winter months and low flows of 11 cfs during late summer have been reported.

Forestry is the major land use in the Miami Subbasin comprising 38.3 square miles or 96 percent of the total in the basin (Table 3). Forestry activities occur in the hills and mountains surrounding the main river alluvial plain that begins at approximately river mile 5.5 with the forest-agriculture boundary.

Table 3 . From USDA-SCS Main Report Table IV-1

LAND USE vs. DRAINAGE

TILLAMOOK BAY DRAINAGE BASIN - 1975

Land Use	Tillamook Ac.	Miami Ac.	Kilchis Ac.	Wilson Ac.	Trask Ac.	Sub-Total Ac.	Total Ac.
Forest Lands 1/							
1. Clearcuts, low brush and seedlings	6,120	4,370	1,530	930	660	13,610	
2. Burns including low brush and seedlings	- -	700	7,410	16,370	20,500	44,980	
3. Old-growth	1,290	1,490	2,630	15,010	10,140	30,560	
4. Mature second growth	4,530	3,130	4,830	15,580	8,180	34,250	
5. Pole timber	11,920	5,500	9,390	27,960	18,060	72,830	
6. Saplings	3,930	2,230	3,820	12,960	16,090	39,030	
7. Tall brush and seedlings	3,010	2,330	4,030	11,590	12,540	33,500	
8. Hardwoods	2,680	4,520	9,140	20,050	14,470	50,860	
9. Forested pasture	1,640	220	460	400	710	3,430	
Subtotal	35,120	24,490	43,240	118,850	101,350	323,050	323,050
Agricultural Lands 1/							
1. Irrigated pasture	120	200	460	1,120	1,820	3,720	
2. Other wet pasture	960	-	-	-	-	960	
3. Dry pasture unimproved	1,240	170	470	480	1,660	4,020	
4. Dry pasture improved	4,370	360	1,620	1,790	5,330	13,470	
5. Brush pasture	570	90	210	190	310	1,370	
Subtotal	7,260	820	2,760	3,580	9,120	23,540	23,540
Water 2/							
1. Rivers	280	70	280	600	600	1,830	
2. Bays	- - - - - -	- - - - - -	- - - - - -	-9,150-	- - - - - -	9,150	
Subtotal	280	70	280	600	10,980	10,980	10,980
Rock and Sand							
1. Other lands	40	--	500	2,380	1,110	4,030	
2. Bay	- - - - - -	- - - - - -	- - - - - -	-190-	- - - - - -	190	
						4,220	4,220
Urban	440	170	140	130	850	1,730	1,730
TOTAL	43,140	25,550	46,920	125,540	113,030	- -	363,520

1/ Road and trail rights-of-way are also included in each acreage of this table. A more detailed analysis follows.

2/ Water listed above includes only streams wider than 10 feet and water bodies four acres or larger in size.

Source of Data: USDA staff using the PIXSYS Program at Oregon State University

Agricultural lands comprise most of the remaining four percent (820 acres) of the land which occurs in the narrow flood plain of the main river. This land is devoted mostly to forage crop for dairy cattle. The crops are harvested by pasturing, green chopping, or made into silage. About 200 acres of the 820 acres is irrigated (USDA-SCS, 1978). There are five dairy farms located along the lower five to six miles of the main river with approximately 565 cattle generating an estimated 27,900 cubic feet of manure per year (Tillamook SWCD, 1980).

There are no concentrations of homes in any area within the Miami subbasin. In addition to farm homes, there are occasional permanent residential or vacation homes sparsely distributed throughout the lower basin. They primarily occur near streams or on hillsides which afford a view of the valley. It is estimated that 125 people live in the subbasin (see Table 2).

Recreation in the subbasin consists mainly of fishing, swimming, deer and elk hunting, and camping. Oregon Fish and Wildlife (Personal Communications, Dave Heckeroth, 1980) report that a yearly average (1974-1978) of 8688 angler days were spent harvesting 3604 salmonid species fish (Table 4). Although there are no state parks or improved recreation sites located in this subbasin, this does not mean swimming and camping do not occur. Deer and elk hunting occurs in the upland area. Oregon Department of Fish and Wildlife (Doug Taylor, Personal Communication, 1980) reports that 139 deer and 58 elk were harvested in 1979. The standing population of deer and elk is estimated to be 1300 deer and 270 elk (Table 5).

Kilchis River Subbasin

The Kilchis watershed covers 46,920 acres (73.3 sq. miles) of land northwest of Tillamook Bay in the north central part of the project area (see Plate 2). The water flows southwest into the southeast portion of the bay approximately one mile north of the Wilson River mouth.

The main stem Kilchis River is about 14 miles long. The north and south forks reach another 6 miles into the west slope of the Coast Mountain Range. Many small tributaries of one to three miles in length, feed the main stem throughout its entire length.

Coal Creek Reservoir, a private water supply located on Coal Creek, is the only lake in the basin. It is approximately 1 acre in size with a storage capacity of 7.67 acre-feet. In a sample from a November, 1972 survey (USGS, 1973) of the lake, 162 total coliform bacteria organisms/100 ml were isolated. Other small ponds may be located elsewhere in the Kilchis Subbasin.

Stream gradients in the main stem vary from about less than 1 percent in the flood plain to about 10 percent in the headwater area. Tributary gradients exceed 20 percent in places. Tidal influence occurs in the lower 4.5 miles of the main river.

TABLE 4 Tillamook Bay Drainage Basin Fishery Data
Average Annual Harvest and Use

Water	Angler Days /1.	Salmonid Species Caught /1.
Miami R.	8,688	3,604
Kilchis R.	9,970	6,158
Wilson R.	44,986	14,204
Trask R.	35,775	17,330
Tillamook R.	4,824	3,304
Tillamook BAY	18,375	2,827
TOTALS	122,618	47,427

/1. Based on 1974-78 Average (5 yrs.) Dave Heckeroth, Oregon Department of Fish and Wildlife 1980.

TABLE 5

ESTIMATED ANIMAL POPULATIONS, HARVEST, AND HUNTER USE FOR THE TILLAMOOK BAY DRAINAGE BASIN

(Doug Taylor, Oregon Fish & Wildlife, 1980)

	1979 Deer Harvest	1979 Elk Harvest	1979 Deer Hunters/Days	1979 Elk Hunters/Days	1980 Est. Deer Population	1980 Est. Elk Population
MIAMI[1] 38 mi.[2]	139	58	603/3,427	463/3,026	1,300	270
KILCHIS[1] 68 mi.[2]	249	104	1,080/6,132	829/5,420	2,300	480
WILSON [1] 186 mi.[2]	682	285	2,954/16,777	2,269/14,824	6,300	1,310
TRASK[2] 158 mi.[2]	527	38	2,323/14,814	800/3,206	4,100	520
TILLAMOOK[2] 55 mi.[2]	183	13	815/5,156	279/1,116	1,400	180
Total for Tillamook Bay Drainage Basin	1,700	498	7,795/46,306	4,640/27,592	15,400	2,760

1 Wilson Game Management Unit
2 Trask Game Management Unit

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The drainage pattern of the Kilchis subbasin has a trellis distribution and a pear shape. Drainage density for the forest and agriculture lands is 1.32 and 6.03 stream miles per square mile of land respectively. Very little stream meandering occurs in the lower flood plain. The alluvial plain varies in width up to approximately 1 mile in the lower basin. Few drainage ditches are noted which surface water to streams. No main river channel changes are noticeable. However, some channel changes of small tributaries (e.g. Murphy Creek) have occurred in past years to allow better utilization of pasture land. Gravel mining in the main river streambed occurs during low flow seasons between river miles 6 and 8. There are no tide gates or diking on the lower Kilchis River.

The Kilchis River subbasin can be divided into two regions relative to runoff potential. The upper subbasin covering about 43,240 acres (67.6 sq. miles) down to Myrtle Creek (river mile 4.7) can be classed as having a high runoff potential (see explanation of runoff potential in Miami River Subbasin Section). The lower subbasin, from Myrtle Creek to the bay, is almost a 50/50 split between moderate and high. Three percent of the lower subbasin near the mouth of the river is considered to have a very high runoff potential.

The mean annual discharge from this basin, as measured by a State of Oregon Water Resources Division staff gauge at river mile 2.5 (Curl Road Bridge) is 345,564 acre feet (USDA-SCS, 1978). This constitutes approximately 13 percent of the fresh water reaching Tillamook Bay. Peak flows of 11,360 cfs during winter months and low flows of 10 cfs during late summer have been reported.

Forestry is the major land use in the Kilchis Subbasin covering 67.5 square miles (43,240 acres) or 93 percent of the total land area in the basin (see Table 3). The forests are located in the hills and mountains surrounding the valley bottom of the main river that begins at approximately river mile 7.0.

Agriculture occupies most of the remaining 7 percent of the land. Forage crops for dairy cattle are grown on the alluvial bottom land of the main stem valley up to the forest-agriculture land use boundary at about river mile 7.0. These crops are harvested by pasturing, green chopping, or made into silage. About 460 acres of the 2,760 acres of agriculture land is irrigated (USDA-SCS, 1978). There are 13 dairy farms with approximately 1,615 cattle generating an estimated 90,356 cubic feet of manure per year in the watershed (Tillamook SWCD, 1980).

Housing occupies 140 acres mostly in rural development of permanent and vacation homes. Some of these homes are within close proximity to streams. There is no subdivision style concentration of homes. It is estimated that 370 people live in the subbasin (see Table 2). There is no municipal sewage tretment system in this subbasin.

Recreation in the subbasin consists mainly of fishing, swimming, hunting picnicking and camping. Oregon Fish and Wildlife (Personal Communication, Dave Heckeroth, 1980) reports 9,970 angler days and 6,158 salmonid species fish harvested yearly (average, 1974-1978) (Table 4). Deer and elk hunting occur in the upland area with 249 deer and 104 elk harvested in 1979 (see Table 5, Personal Communication Doug Taylor, Oregon Department of Fish and Wildlife, 1980). The standing game population is estimated to be 2,300 deer and 480 elk. Tillamook County operates Kilchis County Park for camping, picnicking, and fishing (Plate 3). This park extends from river mile 6 to river mile 9.5. The park is equipped with flush toilet sanitary facilities. The county parks division reports that on a warm weekend or a holiday, 400 people per day will use the park. This subbasin also provides numerous opportunities for swimming, camping, and fishing upstream from the county park location.

Wilson River Subbasin

The Wilson River drains 125,540 acres (196.2 sq. miles) of land northeast and east of the Tillamook Bay. The river flows southwest and enters the bay on the southeast shore (see Plate 2).

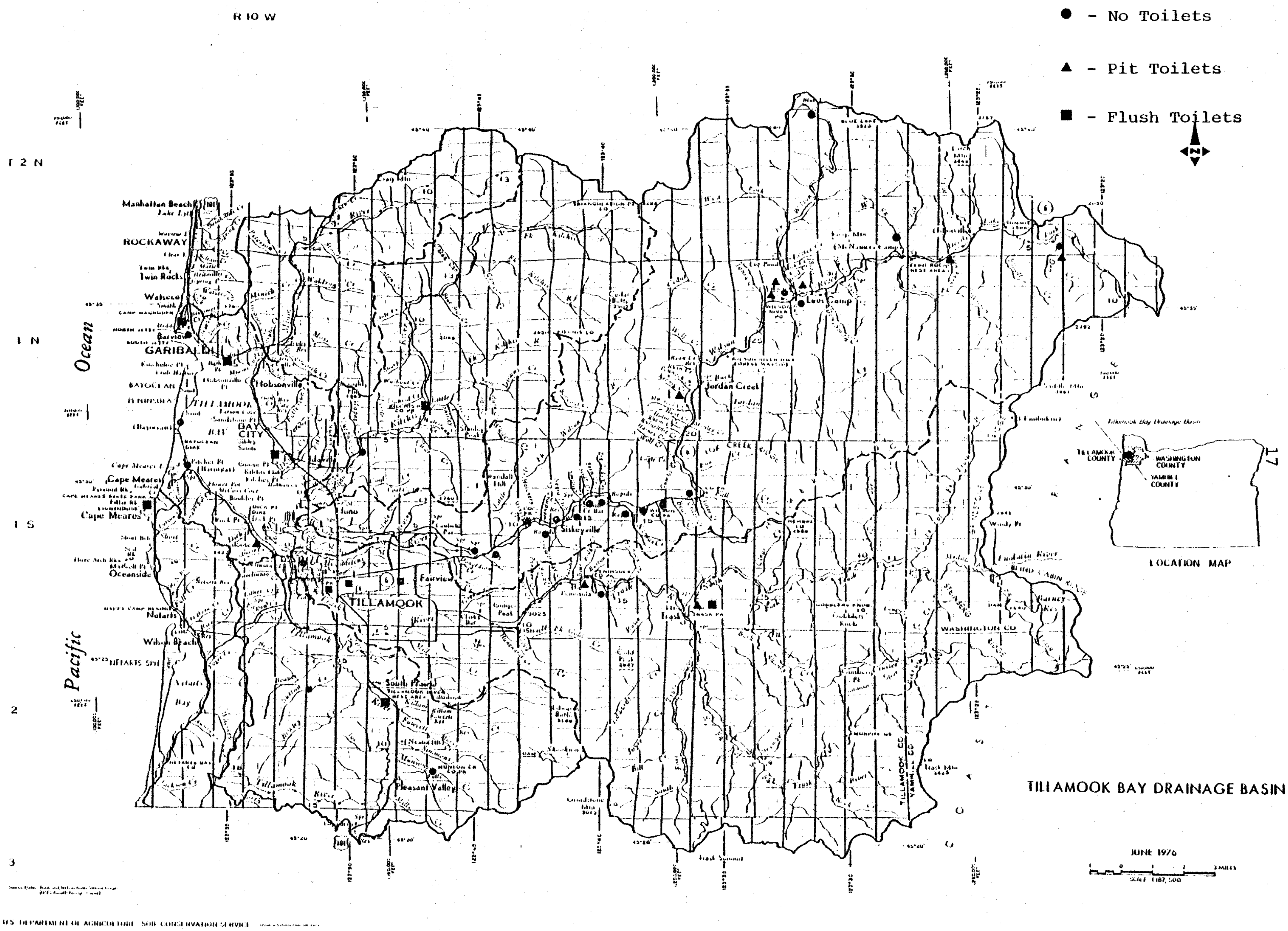
The main Wilson River reaches approximately 33 miles into the west slope of the steep Coast Mountain Range. Two large tributary systems, Devils Lake Fork and North Fork Wilson each extend an additional 10 miles into the mountains, extending the headwaters of the Wilson about 43 river miles from the bay. Another large tributary, the Little North Fork Wilson, extends about 11 miles into the mountains from its confluence at river mile 8.5 of the main stem Wilson. Many smaller tributaries feed these larger streams and vary in length of 1 to 8 miles.

Blue Lake and Ryan Reservoir are also a part of the drainage system in this basin. Blue Lake, a small deep lake, used primarily for fishing, is located on the upper end of the North Fork Wilson River. It has a surface area of 3 acres and contains 50 acre-feet of water. A November 1972 survey (USGS, 1973) sample contained 16 total coliform bacteria/100 ml of water. Ryan Reservoir, (Locally known as Smith Hole) a private recreation lake, is less than one acre in size and stores about 1 acre-foot of water. The bacteria quality for the same sample period was 50 total coliform/100 ml of water (USGS, 1973). Small ponds also may be located in the Wilson River Subbasin.

Stream gradients in the main stem vary from less than one percent in the alluvial plain to 3 percent in the upper region. Tributary gradients also vary from less than 1 percent to 30 percent. Tidal influence occurs to river mile 3.0.

The drainage pattern of the Wilson subbasin has a trellis distribution and a pear shape. The forest lands have a 0.62 stream mile per square mile drainage density, while the agriculture lands have a 1.00 drainage density. Very little stream meandering occurs in the lower river. The alluvial plain starting at river mile 7.5 is very narrow considering the broad plain seen traveling west on State Highway 6. Most of the broad plain drains into the Bay via the many sloughs located throughout this plain. The narrow Wilson River Valley bottom is about 1/2 mile wide from the point of

Plate 3. SANITARY FACILITIES AT RECREATION SITES.



exit from the mountains to the point of entry to the bay. (Dougherty Slough parallels the south side of the Wilson River and drains to the Bay, via Trask River). This slough however becomes a flood water channel for the Wilson River during high flows.

The Wilson River has been extensively diked on either one or both sides from about river mile 6 to the mouth. Additional rip-rapping and rock jetting has been done in various places to minimize bank erosion and channel meandering. A streambed gravel mining operation occurs during the low flow season at about river mile 7.5.

Most drainage ditches in the lower basin occur along roads. A few ditches occur in the pastures below where U.S. Highway 101 crosses the subbasin. No tide gates are located in this subbasin.

Runnoff potential for the Wilson River Subbasin can be described as mostly high (see the explanation of runoff potential in Miami River Subbasin Section). However, about 35 percent of the basin can be classified as having moderate runoff potential occuring in the valley bottom and 2 percent very high potential occuring in the Blue Lake, Larch Mountain area of the upper watershed.

The mean annual discharge from this basin, as measured by a U.S. Geological survey gauge at river mile 11.5, (above the Little North Fork influence) is 1,022,790 acre feet (USDA-SCS, 1978). This accounts for approximately 39 percent of the total fresh water entering the bay. Peak flows of 36,000 cfs have occurred in winter months and low flows of 32 cfs have occurred during late summer.

Forestry is the major land use covering 118,850 acres (185.7 square miles) of the subbasin (see Table 3). Within the forested areas, are occasional small concentrations of residential and vacation homes. They occur at Lee's Camp (river mile 28.5), Jordan Creek (river mile 22) and the Narrows Subdivision (about river mile 16). The forest occupies the hills and mountains surrounding the agricultural lands which extend up to the forest-agriculture land use boundary at river mile 7.5.

Agriculture land use occupies about 5 percent of the subbasin (3,580 acres) and is located on the alluvial plain of the main river. Forage crops for dairy cattle harvested by pasturing, green chop, or made into silage are the predominant type of agriculture. About 1,120 acres of this land are irrigated (USDA-SCS, 1978). Nineteen dairy farms with 2,679 cattle producing an estimated 148,070 cubic feet of manure per year are located within this drainage system (Tillamook SWCD, 1980).

Urban lands occupy about 130 acres. These are mostly rural developments. An occasional concentration of homes or subdivisions occur mostly near streams or on hillsides (e.g. Lee's Camp, Jordan Creek, the Narrows, Northwood Acres Subdivision, homes along the north side of the Wilson River on Sollie Smith Road). None of these are located in a sewage service district. It is estimated that 1195 people live in the Wilson River Subbasin (see Table 2).

A treatment facility treating both industrial and domestic waste, discharges treated effluent to the Wilson River at river mile 1.5. This facility is operated by the Tillamook County Cremery Association cheese factory. National Pollution Discharge Elimination System (NPDES) Permit No. 2926-J for this facility limits the discharge to 0.95 MGD (0.2 process and 0.75 cooling). Fecal coliform levels in this discharge are limited to 200/100 ml daily average and 400/100 weekly average based on a geometric mean. Current daily waste load maximums are 150 pounds BOD and 166 pounds total suspended solids.

Because of the easy access provided by State Highway 6 from the Portland metropolitan area, 60 miles to the east, many people recreate or travel through this basin. There are many improved and unimproved areas for camping, hiking, picnicking, fishing, swimming, hunting, and also off road vehicle use (mostly motorcycles) scattered throughout the mountainous terrain of this basin. These areas are located near streams which provide easy access to water related recreation. Boating on limited portions of the main river also occurs.

Oregon Fish and Wildlife (Personal Communication, Dave Heckeroth, 1980) reports 44,786 angler days harvesting 13,604 salmonid species fish (Table 4) occurs in the Wilson River watershed (yearly average, 1974-1978). Standing herds of 1,310 elk and 6,300 deer roam the basin with 285 elk and 682 deer harvested in 1979 (Personal Communication, Doug Taylor, Oregon Fish and Wildlife, 1980) (see Table 5).

Trask River Subbasin

The Trask River drainage consists of 113,030 acres (176.6 sq. miles) of land east to southeast of Tillamook Bay. The river flows west and enters the south portion of the bay near the City of Tillamook and 1 mile south of the Wilson River mouth (see Plate 2).

The main river extends approximately 18 miles up the mountainous west slope of the Coast Range. From there the river divides into the North and South Forks which extend an additional 12 to 18 miles into the mountains. A number of large tributary watersheds feed each of the forks and many small tributaries of 1 to 3 miles in length empty into the main stem river.

No lakes are found in this subbasin, although small ponds of less than one acre in size are located in the watershed.

Stream gradients in the main stem vary from less than 1 percent near the bay to 2 percent in the mountains. Tributary gradients also vary from less than 1 percent to 5 percent. Tidal influence occurs in the lower 4.5 miles of the main river.

The drainage pattern of the Trask subbasin has a trellis distribution and a pear shape. Stream density is 0.82 stream miles per square mile of land in the forest and 2.71 in the agricultural lands. Very little stream meandering occurs in the lower river. The alluvial plain starts at about river mile 10.5 and extends to the mouth, varing in width from 1/4 mile to 4 miles. This broad alluvial plain is drained by the Mill Creek watershed and the Dougherty and Hoquarten Sloughs. The City of Tillamook sits on a terrace between the Trask River to the south and the sloughs to the north which drain the area adjoining the Wilson River Subbasin. Holden Creek, also a tributary to the Trask drains the urban area of the city of Tillamook and enters the Trask at river mile 2.5. The river is diked on either one or both sides in the lower 2.5 mile downstream of the Highway 101 bridge. A few drainage ditches behind these dikes and along roads convey surface water to the river. A number of tide gates have been installed in these dikes to allow drainage of the adjoining land and to prohibit flooding at high tide (Plate 4). The tide gates are maintained by incorporated drainage districts established to reclaim lower tide lands and to prevent flooding. A streambed gravel mining operation occurs at about river mile 8 during the low flow season.

The runoff potential in the Trask River subbasin can be classed as moderate to high (see explanation of runoff potential in Miami Subbasin Section).

However, most of the high runoff potential is found in the south fork system where 76 percent of the area is classed as high. One percent of the Trask watershed total area is considered to have a very high runoff potential. This area is located in the lower 1 to 2 miles extending mostly up the Hoquarten slough drainage.

The drainage from this basin is not measured regularly. A U.S. Geological survey gauge at river mile 10.4 was removed in 1972. The county and Port of Tillamook have a flood gauge located at river mile 3.5. Mean annual discharge determined for the U.S. Department of Agriculture-Soil Conservation Service Sediment Study (1978) was 811,904 acre feet (see Table 1). This accounts for about 15 percent of the fresh water entering the bay. Peak flows of 23,000 cfs have occurred in winter months and low flows of 42 cfs have occurred during late summer months.

Forestry is the major land use occupying 101,350 acres (158.4 square miles) or 90 percent of the subbasin (see Table 3). Forests occupy most of the land from the top of the watershed to the main stem river mile 10.5 where the forest-agriculture land use boundary occurs.

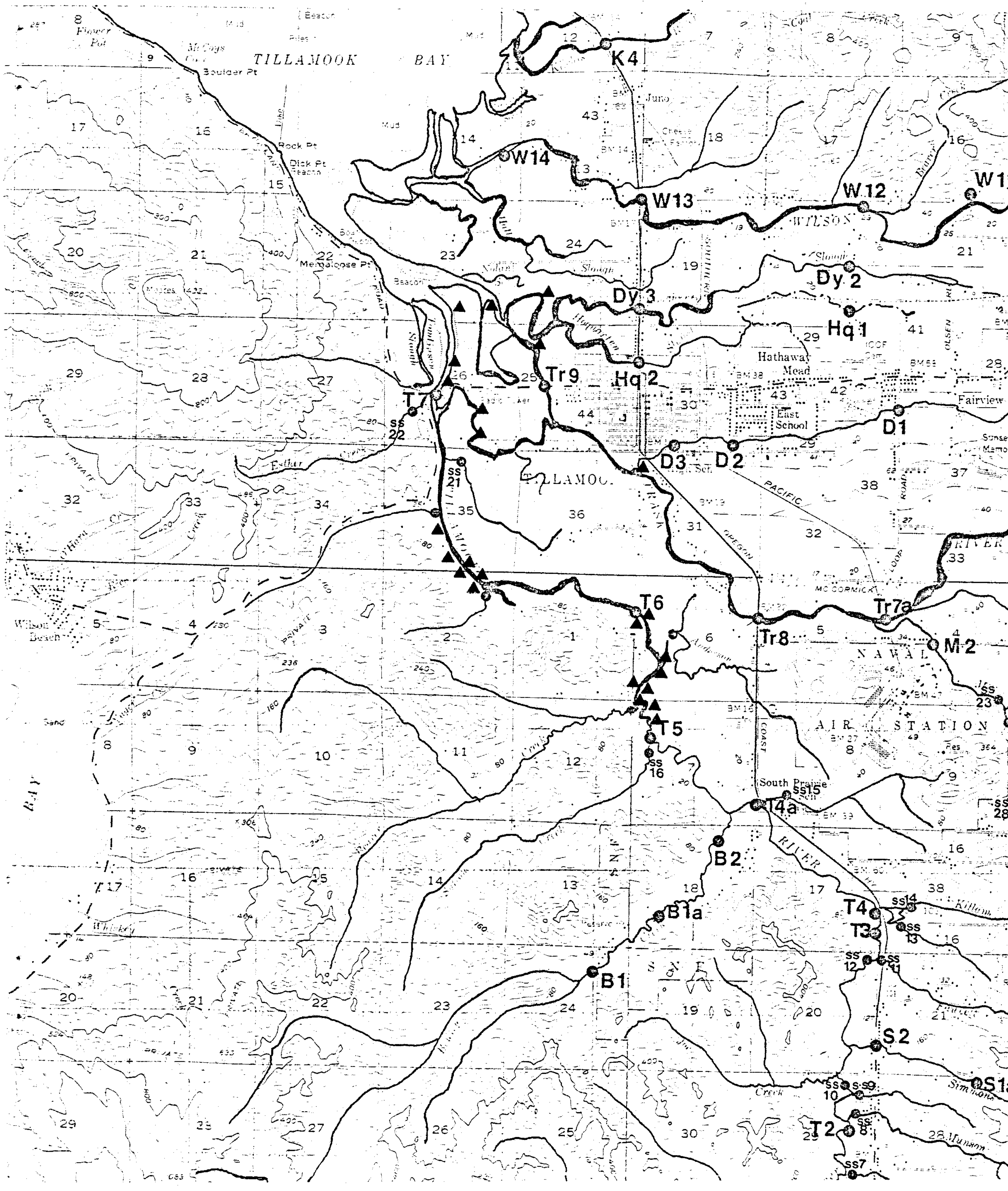
Agriculture in the form of forage crops for dairy cattle covers 9120 acres (14.3 sq. miles) or 8 percent of the total land area of the basin. These forage crops are harvested by pasturing, green chop, or are made into silage.

About 1,820 acres are irrigated (USDA-FDS, 1978). There are 40 dairy farms with 6,251 cattle producing estimated 340,111 cubic feet of manure per year in the Trask River basin (Tillamook SWCD, 1980).

Urban lands occupy about 850 acres in this subbasin. These lands include the sanitary sewered City of Tillamook (population 3,968 in 1970) and its partially unsewered suburbs. The Port of Tillamook's industrial park and

Plate 4 Tidegate Placement in Tillamook Bay Drainage Basin - Tillamook Soil Conservation Service, March 18, 1980.

▲ - Tide Gates



airport also occupies a portion of the basin. Two sewage treatment plants (STP) discharge into the Trask River. A sewage treatment lagoon at river mile 5 services the Port of Tillamook (NPDES Permit No. 2667-J, 0.56 MGD); no discharges to public waters are allowed June 1 to October 31; from November 1 to May 31 fecal coliform limits of 200/100 ml monthly average and 400/100 ml weekly average; from November 1 to May 31 effluent loadings of 280 lbs. daiy, 210 lb/day weekly average, 140 lb/day monthly average for BOD and 460 lbs daily, 350 lb/day weekly average, 233 lb/day monthly average for total suspended solids.) which includes a lumber mill and school. The other STP (NPDES Permit No. 2901-J, 1.06 MGD; waste discharge limitations for June 1 to October 31: fecal coliform, 400/100 weekly average concentration and 200/100 ml monthly average; BOD of 3541 lbs daily, 265 lbs/day weekly average, 177 lbs/day monthly average; total suspended solids of 354 lbs daily, 265 lbs/day weekly average, and 177 lbs/day monthly average. Waste discharge limitations for November 1 to May 31: fecal coliform, 400/100 ml weekly average concentration and 200/100 ml monthly average; BOD of 530 lbs daily, 398 lbs/day weekly average, 265 lbs/day monthly average; total suspended solids of 530 lbs daily, 398 lbs/day weekly and 265 lbs/day monthly average) services the city, including the Tillamook County Hospital, and discharges at river mile 1.5. The urban stream named Holden Creek flows through many backyards, less than 10 acre "hobby farms" and a lumber mill log dump prior to entry into the Trask River at river mile 2.5. Rural development consists mainly of scattered residential and vacation homes mostly along streams. A concentration of small homes occurs at the town site of Trask which is located at the confluence of the North and South forks, 18 miles up river from the bay. The estimated population of the Trask Subbasin is 6,300 (see Table 2) of which an estimated 2,100 people live in unsewered areas.

Recreation in this subbasin is extensive. Water related recreation include boating on limited portions of the main river, fishing, swimming, camping, and picnicking. Peninsula County Park and Trask River State Park are the main concentrations of recreation. Off road vehicle use, hiking, and hunting also occur in many parts of the mountainous portions of the watershed. An organized boat outing which attracts many aboars and people standing on the shore, occurs every spring on the main river. These activities occur in many improved and unimproved sites (see Plate 3). Two Oregon Department of Fish and Wildlife fish hatcheries, located in the South Fork system, provide additional sight-seeing opportunities for the public. A yearly average of 35,775 angler days harvesting 17,330 salmonid species fish (see Table 4) was reported by the Oregon Fish and Wildlife (Personal Communication, Dave Heckeroth, 1980). There are an estimated 520 standing elk and 4,100 deer in the basin. In 1979, 38 elk and 527 deer were harvested from this subbasin (Personal Communication Doug Taylor, Oregon Fish and Wildlife, 1980) (see Table 5).

Tillamook River Subbasin

The Tillamook River watershed consists of 43,140 acres (67.4 sq. miles) of land located south of Tillamook Bay. The main river flows north and enters the bay at the southern tip where the Trask River enters (see Plate 2).

The Tillamook River Subbasin differs from the other four subbasins in that this subbasin has its headwaters on the rain shadow side of the Cape Lookout headlands, 18 river miles southwest of the bay. The tributaries in the east portion of the basin drain the west slope foothills of the Coast Range, while the tributaries in the west portion drain the east slope of the hills which separate the Tillamook River Valley from the ocean. These tributaries vary from 1 to 6 miles in length. The City of Tillamook's water supply source is an east side tributary of the Tillamook River.

Skookum Reservoir located at the upper end of Fawcett Creek is the only lake located in this subbasin. This lake is part of the water supply system for Tillamook and is closed to the public. It has a surface area of about 40 acres and holds about 700 acre-feet of water. In a U.S. Geological Survey sample (November 1972) 82 total coliform bacteria/100 ml of water were isolated. Small ponds of less than one acre size also may be located elsewhere in the subbasin.

Stream gradients in the main stem vary from less than 1 percent to 17 percent in the upper reaches. Tributary gradients vary from 1 percent to 20 percent. Tidal influence reaches to river mile 5.

The drainage pattern of the Tillamook subbasin has a palmate distribution and a pear shape. The drainage density (stream mile per square mile of land drained) is 1.33 for forest lands and 3.76 for agriculture lands. The main river meanders throughout the alluvial plain.

The alluvial plain extends 16 of the 18 main stem river miles. The plain varies in width from 1/4 mile in the upper reaches to about 1 mile at the lower end. This alluvial plain is extensively disected by streams and drainage ditches. The lower 5 miles of the main river is diked on one or both sides. Numerous tide gates are placed in these dikes to permit surface drainage and to prohibit backflooding during high tide (see Plate 4). The tide gates are maintained by incorporated drainage districts to reclaim tide lands and prevent flooding.

The runoff potential for the Tillamook River can be classed as moderate (see explanation of runoff potential in Miami Subbasin Section). Sixty-three percent of the land located on the east half the basin is classed moderate runoff potential (USDA-SCS, 1978). Twenty-nine percent of the land is given a high runoff potential and is located in the upper main stem and west side tributary watersheds. Six percent of the watershed has a very high runoff potential. This area is predominantly the same area of the watershed that is behind dikes and tide gates (see Plate 4).

The mean annual discharge from this basin, as measured by an Oregon Water Resources Department staff gauge at river mile 6.5 (Bewley Creek Road Bridge) is 251,775 acre feet which accounts for about 9 percent of the fresh water entering the bay. Peak flows of 3,400 cfs have occurred in winter months with low flows of 8 cfs have occurred during late summer months.

Forestry is the major land use for the subbasin. It covers 35,120 acres (54.8 sq. miles) or 81 percent of the land area of the basin (see Table 3). This percentage is less than the other basins due to the larger area occupied by the alluvial plains. The forest-agriculture land use boundary occurs at about river mile 16 on the main river.

Agriculture occupies most of the alluvial plains and takes up about 17 percent of the basin area. It consists mostly of forage crops for dairy cattle of which harvesting is by pasturing, green chop, or are made into silage. About 120 acres of the total 7,260 acres (11.3 sq. miles) is irrigated. There are 38 dairy farms, 4,543 cattle producing an estimated 236,133 cubic feet of manure annually in the Tillamook River Basin (Tillamook SWCD, 1980).

Urban lands make up the remaining 2 percent (440 acres) of the land area. Development is rural with concentrations of people occurring at South Prairie and Pleasant Valley. Occasional small subdivisions occur in the basin. None of this basin is serviced by a sewer system. Most homes have septic tanks. Toilet paper floating in the main river has been reported, by fishermen. This observation raises concerns about some of the older homes not having septic systems, but rather, pipes to the river. A sanitary landfill is also located in this subbasin near Beavercreek. An estimated 910 people live in the Tillamook River Subbasin (see Table 2).

Recreation in this subbasin consists primarily of picnicking, camping, hiking, fishing and some hunting. U.S. Highway 101 traverses this basin providing easy access to upper watershed areas. Munson Creek County Park serves as a day use area. Skookum Reservoir Lake is not open to the public. Sutton Creek Reservoir provides camping, fish, and swimming in an unimproved area. A limited number of improved or unimproved areas occur elsewhere in the basin (see Plate 3). Tillamook River Wayside, owned by the state of Oregon, is located along the Tillamook River about four miles south of the City of Tillamook.

The Oregon Fish and Wildlife reports 4,824 angler days yearly average, (1974-1978) with a catch of 3,304 salmonid species fish (Personal Communication, Dave Heckeroth, 1980) (see Table 4). There are an estimated standing crop of 180 elk and 1,400 deer in the basin. In 1979, 13 elk and 183 deer were harvested in the same area (Personal Communication, Doug Taylor, Oregon Fish and Wildlife, 1980) (see Table 5).

Near Bay

The Near Bay Area is that land around Tillamook Bay which is not included in one of the five river basins described above. These lands include Bay Ocean Peninsula, hill slopes of Cape Meares facing the bay, slough areas between the Trask and Wilson River Basins, the hill slopes facing the bay from Idaville to Miami Cove and the hill slopes facing the bay from Miami Cove to Barview.

The Bay Ocean Peninsula is a sand spit that extends north from Cape Meares to the mouth of Tillamook Bay. It consists of sand and dredge spoils covered with grass and a few trees. Only one body of water is visible on it. Cape Meares Lake (identified as Biggs Cove on early maps) was formed by the closing of a breach in the spit that occured in 1953. It is a freshwater lake with an inflow from a bog area on the southwest edge which receives surface and groundwater from the nearby community of Cape Meares (population 300 in 1970). The outflow to Tillamook Bay is controlled through the dike on its east side. The lake has a surface area of about 65 acres and holds approximately 320 acre-feet of water used for cutthroat trout fishing and water fowl hunting. A U.S. Geological Survey sample on October, 1971, isolated 6,000 total coliform bacteria per 100 ml. of water. Recreation and access to ocean beaches are the primary uses of the spit.

The slopes of Cape Meares that face north to Tillamook Bay (from Bay Ocean Peninsula to the mouth of Tillamook River) have a few small (one to two mile long) creeks that discharge directly to the bay. The uplands of this portion of the near bay contain timber which is currently being harvested. The shore line is predominantly residential with the exception of an oyster processing facility. A county owned boat launch facility provides access to the bay and lower Wilson, Trask and Tillamook Rivers for fishermen. Recreational use of this area is limited because of narrow road shoulders along the bay and the steepness of the terrain upslope from the bay. The residential area is not sewered and may be inadequate for subsurface systems due to the lack of suitable land for the systems.

The slough areas between the Trask and Wilson Rivers consist mainly of Hall Slough and low lying tidal areas made up of flood plain alluvium. Seasonal high water is common over much of the area. Land use in this area consists mainly of dairy farms. Recreation includes hunting and fishing along the shorelines. Residential density is very low due to the land requirements for the dairy operations.

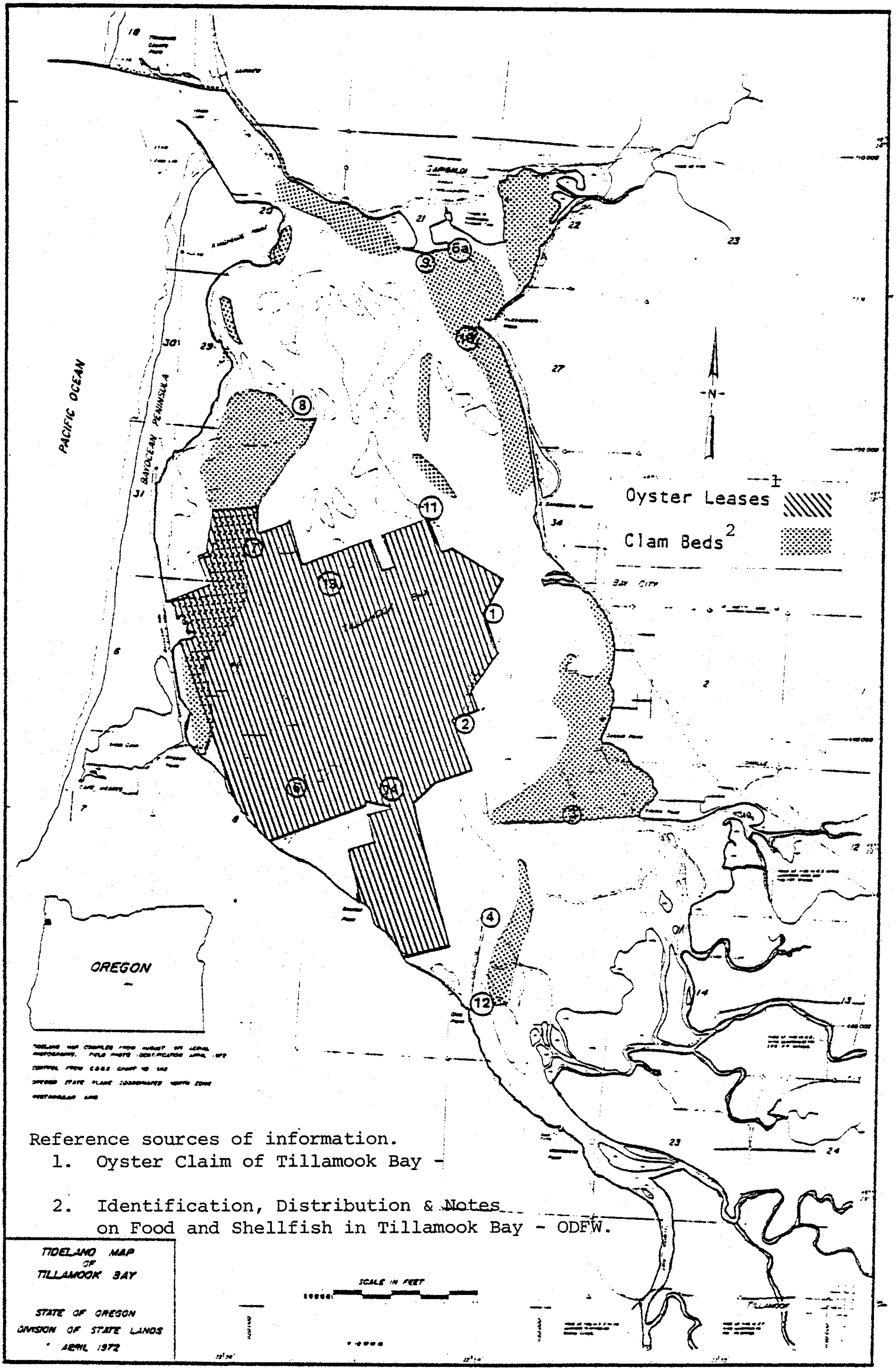
The area from Idaville to Miami Cove consists of hill slopes facing the bay that is dissected by a number of streams that discharge directly to the bay. The upland terrain is forested with residential use occuring along some of the creeks. Patterson Creek flows through the sewered residential area of Bay City while Vaughn Creek flows through the unsewered area of Idaville. Larson Creek, located north of Bay City, has a dump located in its watershed. The dump was covered with sand and closed in 1975. Considering the type of wastes including seafood processing wastes, the annual precipitation and the material used for final cover at closure time, the likelihood that leachate is coming out of the old site is very good. The other creeks are primarily forested with little residential development near them. Dairy farming only occurs near Idaville. A major oyster processing plant is located on a narrow fill into the bay at Bay City. Population of Bay City, Idaville, and adjoining areas was estimated to be 1,400 in 1970. Recreation in this area, aside from an occasional camper at an unimproved campsite, is restricted to shore-line use of the bay. The Bay City sewage treatment plant composed of lagoons discharging to the bay at Bay City. (NPDES Permit No. 2656-J, 0.21 MGD; waste discharge limitations for June 1 to October 31: fecal coliform, 400/100 ml weekly average concentration and 200/100 ml monthly average; BOD of 105 lbs daily, 79 lbs/day weekly average, 52 lbs/day monthly average; total suspended solids of 175 lbs daily, 140 lbs/day weekly average, and 88 lbs/day monthly average. Waste discharge limitations for November 1 to May 31: fecal coliform 400/100 ml weekly average concentration and 200/100 ml monthly average; BOD of 105 lbs daiy, 79 lbs/day weekly average, 52 lbs/day monthly average; total suspended solids of 175 lbs daily, 140 lbs/day weekly and 88 lbs/day monthly average.)

The hill slopes facing south to the bay, from Miami Cove to Barview have an occasional less than one mile long streams draining the land. The upland areas are forested. The City of Garibaldi (population 985 in 1980) covers a large portion of the land described here. The city is sewered. The city's sewage treatment plant discharges treated effluent directly to Tillamook Bay (NPDES Permit No. 2944-J, 0.5 MGD; an allowable mixing zone maximum of 300 feet from the point of discharge. Waste discharge limitations for June 1 to October 31: fecal coliform, 400/100 ml weekly average concentration and 200/100 ml monthly average; BOD of 168 lbs daily, 125 lbs/day weekly average, 84 lbs/day monthly average; total suspended solids of 168 lbs daily, 125 lbs/day weekly average and 84 lbs/day monthly average. Waste discharge limitations for November 1 to May 31: fecal coliform 400/100 ml weekly average concentration and 200/100 ml monthly average; BOD of 250 lbs daily, 118 lbs/day weekly average, 125 lbs/day monthly average; total suspended solids of 250 lbs daily, 188 lbs/day weekly average, and 125 lbs/day monthly average.) The Port of Bay City owns the fill into the bay on which a number of seafood processing plants and a boat basin are located. A new boat basin, recently completed, is located at an old lumber mill site at the entrance to Miami Cove. Recreation is heavy in this area and includes boating, sport fishing, rock fishing and sight seeing. Clam digging and bait shrimp harvesting are also near shore activities.

Tillamook Bay

Tillamook Bay (Plate 5) is an estuary six miles long, north to south, with a maximum width of three miles. The esturary from the bay mouth to tidewater is approximately 11 miles. It covers about 14 square miles at high tide and about 7 square miles at low tide. The bay is shallow with an average depth of six feet. At extreme low tides the bay is composed mostly of narrow channels.

Plate 5 . TILLAMOOK BAY WITH OYSTER AND CLAMBEDS.



Reference sources of information.

1. Oyster Claim of Tillamook Bay -
2. Identification, Distribution & Notes on Food and Shellfish in Tillamook Bay - ODFW.

As in preceding sections, the bay is a catch basin for five river systems draining 574 square miles of forested mountains and pastured agricultural lands. The major population centers situated on the bay are Garibaldi to the north, Bay City to the east and Tillamook to the south.

Because of the seasonally large inflows of fresh water, the salinity gradient moves up and down the bay (Figure 2). The lower bay is a high salinity environment that extends up to Bay City in the winter and between the Kilchis River mouth and the Wilson River mouth in the summer (Bottom and Forsberg, 1978). The upper bay is generally an area of low salinity where salinities approach zero during high river flows of winter and spring, and 15 parts per thousand in the low flow, fall period. The water temperature gradient in the bay also migrate seasonally up and down the bay but are more related to ambient air temperatures rather than to freshwater temperatures. High temperatures from 18 to 20 degrees C. occur in the summer and 7 to 9 degrees C. are the winter lows.

Uses of the bay include receiving water for the sewage treatment plant effluents at Bay City and Garibaldi, commercial and recreational finfishing and shellfishing, shellfish farming, sport boating, and a boat basin at Garibaldi.

The yearly average (1974-1978) reported by Oregon Department of Fish and Wildlife shows 18,375 angler days used the bay to catch an average of 2,827 salmonid species fish (personal communication Dave Heckeroth, 1980) (see Table 3). Other species of fish are also caught and account for 6,000 fish and an additional 24,500 angler days (Lauman, et al, 1972).

Shellfishing in Tillamook Bay includes recreational and some commercial clamming and all commercial oyster harvesting. Clamming occurs throughout the bay where species are distributed according to their environmental needs. Clam species include blues or gaper (Schizothaerus nuttalli), cockle (Clinocardium nuttalli), quahog or butter (Saxidomus giganteus), little neck (Protothaca staminea), and soft shell (Mya arenaria), (Figure 3). The estimated annual harvest in Tillamook Bay is 540,000 clams in 18,000 digger days (Lauman, et al, 1972). Oyster harvesting in the bay is entirely commercial. It occurs on 949 acres of the potential 2,084 acres leased by three grower/harvesters (Osis and Demory, 1976). The amount of acreage used will vary each year. The oyster commercially harvested is the Pacific Oyster (Crassostrea gigas). In 1975, Tillamook Bay oyster farmers produced 142,144 pounds of oysters at a value of $280,180 (Forsberg, et. al., 1975).

The boat basin at Garibaldi (owned and operated by the Port of Bay City) is used by commercial and sports fishermen. The average boat population consists of 75 commercial fishing vessels, 75 commercial sport fishing boats, and approximately 80 sport boats. The sport boat population fluctuates with the season from 250 in the summer to about 25 in the winter (personal communication, Henry Dupre, Port of Bay City). A new boat basin east of the existing large boat basin just described was completed in early 1980. The boat capacity of this boat basin is 450 sport fishing boats. This boat basin is privately owned and operated.

Figure 2 . From Bottom & Forsberg, 1978

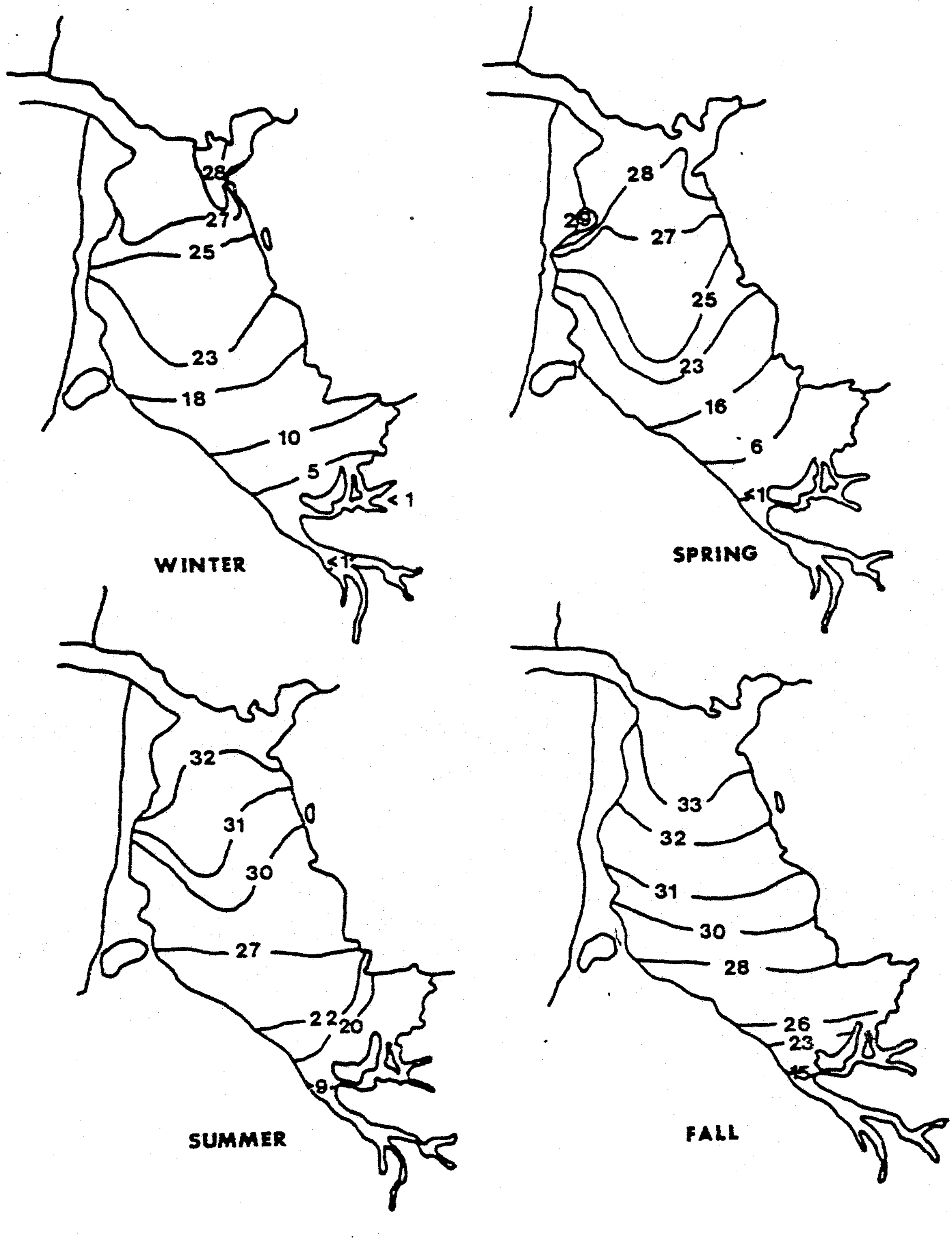


Fig. 6. Average seasonal salinities (°/oo) in Tillamook Bay from samples taken near the botton at high tide.

Figure 3 . From Forsberg, Johnson, Klug, 1975.

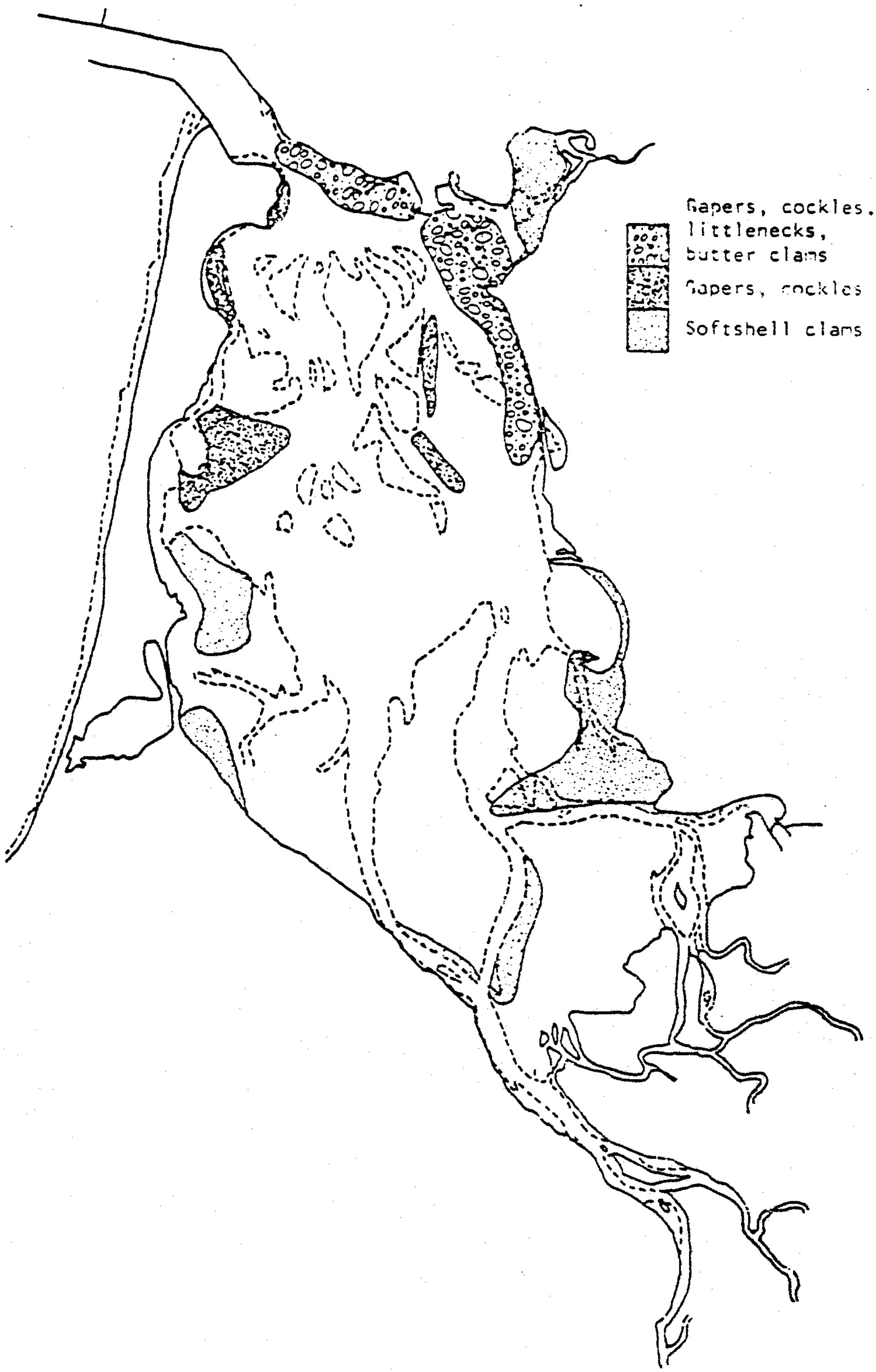


Fig. 48. Identified clam beds in Tillamook Bay.

DEVELOPING THE PROBLEM STATEMENT

The primary mission of the DEQ Water Quality Program is to attain and maintain water quality sufficient to meet in-stream water quality standards throughout Oregon and to protect beneficial uses. This is consistent with the federal goal of fishable/swimable waters where attainable.

Water quality standards specify concentrations of water constituents which, if not exceeded, are expected to provide water suitable for beneficial uses. Many uses may depend upon the same water constituent. The standard level for that constituent is set for the most sensitive of those uses so as to protect that use and the other beneficial uses. Such standards are derived from scientific observation and knowledge of user response to varying water constituent conditions. Therefore, water quality standards are set to protect the life in the water; the direct users of the water; and, as in Tillamook Bay, to protect users that consumer food grown in that water.

Table 6 cites Oregon Administrative Rules, Oregon Department of Environmental Quality, Chapter 340, Division 41, recognized beneficial uses of the water in the North Coast Basin, Oregon, of which Tillamook Bay and its tributaries are a part. These uses are not prioritized nor are they listed as seasonal uses. The DEQ does recognize the seasonality of some of these uses. However, current rules do not allow seasonal adjustment to the standards to protect seasonal uses unless specified by the standard in the referenced rules.

Those uses where the water can be ingested or aquatic life from the water is consumed are uses which need an applicable bacterial water quality standard. These uses include domestic water supplies, industry processing of food using water, water contact recreation, and fishing where the product caught is consumed raw or partially cooked.

Bacteria standards for drinking water are set and administered in Oregon by the Environmental Protection Agency. The drinking water standards dictate the quality of water that should be achieved in municipal water treatment without reference to desirable raw water quality. Although, raw water quality <u>criteria</u> have been developed to aid in selection of water sources such that the surface water can be treated economically to meet the drinking water standards. Refer to Table 7 for the applicable bacteria standards and criteria.

In the food processing industry, the water used is generally from a municipal water supply or ground water. The bacterial water quality characteristics used by the industry are the same as those needed by the public water supply users. Refer to Table 7 for the applicable bacteria standards and criteria.

Water contact recreation requires a bacterial standard for desirable water quality which demonstrates a lack of enteric pathogenic microorganisms from man or other warm-blooded animals. However, one must be careful in

TABLE 6 BENEFICIAL USES OF WATER IN TILLAMOOK BAY DRAINAGE BASIN

	Estuary and Adjacent Marine Waters	All Other Streams and Tributaries Thereto
Public Domestic Water Supply		X
Private Domestic Water Supply		X
Industrial Water Supply	X	X
Irrigation		X
Livestock Watering		X
Anadromous Fish Passage	X	X
Salmonid Fish Rearing	X	X
Salmonid Fish Spawning	X	X
Resident Fish & Aquatic Life	X	X
Wildlife & Hunting	X	X
Fishing	X	X
Boating	X	X
Water Contact Recreation	X	X
Aesthetic Quality	X	X
Hydro Power		
Commercial Navigation & Transportation	X	

TF133.T (8/81)

Table 7. Applicable Bacteria Standards and Criteria for Selected Water Uses

Water Use	Standard	Criteria
Shellfish Growing Water	Log mean of 14 fecal coliform per 100 ml with no more than ten percent of the samples exceeding 43 organisms per 100 ml	Not applicable
Public Drinking Water (Surface source water)	Not developed for source water	Permissible: 2,000 Fecal Coliform/100 ml 10,000 Total Coliform/100 ml Desirable: <100 Fecal Coliform/100 ml < 20 Total Coliform/100 ml
Public Drinking Water (Point of use)	Fermentation tube: 10-60% positive tests in one month depending on sample size. Membrane filter: Arithmetic mean coliform per month shall not exceed 1/100 ml.	Not applicable
Food Processing	Point of use: Same as public water supply.	Surface water (Maximum values): Geometric mean of: Fecal coliform= 2,000/100 ml Total coliform= 20,000/100 ml
Water Contact Recreation	Log mean of 200 fecal coliform per 100 ml based on a minimum of 5 samples in a 30-day period with no more than 10 percent of the samples in the 30-day period exceeding 400 per 100 ml	Not applicable

evaluating recreation water quality by using enteric microbial indicators because not all diseases that seem to be associated with swimming and bathing in polluted water are enteric diseases and are not caused by enteric organisms. Refer to Table 7 for the applicable water contact recreation bacteria standards.

No special bacteria standards is set in Oregon for water supporting sport finfishes. Most people cook fish for consumption although some ethnic groups do prefer to eat raw fish. The cleaning and cooking processes should render fish safe for eating. There are, however, bacteria standards set for shellfish growing waters. The U.S. Food and Drug Administration through administration of its National Shellfish Sanitation Program (NSSP) has established a water quality standard (Table 7) to protect persons consuming raw shellfish (see Appendix A for program description). Oregon State Health Division uses the same standard in administering the Oregon Shellfish Sanitation Program (OSSP). Table 7 also reflects the current standard applied to shellfish growing water by the DEQ and OSHD.

The coliform organisms stated in the standard are bacteria of the enteric group. They are considered to be primary "indicators" of fecal contamination by human or warm-blooded animals. These "indicator organisms" may or may not cause illness. However, they are associated with material (feces) that may be carrying pathogenic viruses or bacteria. Difficulties in isolation and identification of most water borne pathogenic organisms which could be found in lower concentrations and distributed more unevenly than the indicators, necessitate the use of an easily isolated and identifiable bacterium that are associated with fecal matters.

The application of the indicator concept through the use of total and fecal coliform standards is also applied in the Shellfish Sanitation Program both nationally and locally. In the evaluation of shellfish growing areas, two investigative systems are used concurrently--a shoreline or pollution source evaluation and a bacterialogical evaluation of the water looking for an indicator utilizing either total or fecal coliforms. If there exists an identifiable fecal pollution source that could contribute fecal contamination and the indicator organism is found in excess of the standard set for a shellfish growing area, it is then <u>assumed</u> that there is a potential for contacting a disease from eating shellfish. According to public health tradition, presence of sewage as determined by the indicator is presumptive evidence of the presence of pathogens. The same logic also applies to animal feces.

Even though there may be no epidemiological evidence for the presence of pathogens in a body of water, the coliform counts above desirable levels would still indicate that the source of pathogens could exist, a route of transmittal could exist, and such pathogens could be concentrated by the filter feeding shellfish.

The question that results from placing standards to protect benefical uses is, "how does one interpret water quality data to judge whether or not a beneficial use is threatened or impaired?" For the purposes of this report, water quality is evaluated using data that is applied to the standard or criteria in effect at the time the data were gathered. A "standard" applies to any definite rule, principle, or measure established by authority and therefore enforceable. A "criteria" designates a means of evaluation used to form a correct judgment. A criteria carries no connotation of authority and therefore only acts as a yardstick by which to measure water quality without enforcement capability.

Since the standards have been set to protect beneficial uses, any water quality data exceeding a particular standard, such as bacteria numbers, is considered to identify a "polluted" condition at the time the sample was taken. Although a one time sample may not be indicative of the general water quality of that body of water, it does draw attention to the fact the a pollution problem may exist and should be investigated further.

Polluted conditions can result from both natural events such as flooding or landslides and from man's activities. The definition of "pollution" contained in OAR 340-41-006(9) implies that if a public nuisance is not created and the waters are not rendered harmful, detrimental, or injurious to the beneficial uses, a pollution problem does not exist. So when evaluating water data, one must be aware of the beneficial use of the water being investigated, the seasonality (if any) of the uses and the standards and/or criteria limits set to protect those uses. The chapter that follows on testing of the existing data takes these points into account when evaluating the existing knowledge of the bacteria levels in Tillamook Bay.

DATA REVIEW

The goal of the data review process was to determine if there was enough information available to adequately determine if (1) a bacteria problem exists in Tillamook Bay that is impacting the shellfish resource and identified beneficial use of the water, (2) if a problem exists, then what causes it, how and when and where does it occur and (3) what can be done about it. A series of questions was formulated to address each of the topic areas mentioned here. These questions were structured so that if a problem was identified, the answer to the questions would provide information necessary to correct the problem. If the needed information were not available, then a gap in our knowledge was noted and the work plan for the project structured to obtain that knowledge.

The first part of this section is a report identification and summary statement of each piece of information that was found that might have information pertaining to the suspected problem and its corrective action. Numerous reports and papers about Tillmook Bay were found but only those items that were judged to apply to the problem or provide information in aiding identification of the problem are reported here.

Experience shows that additional material may be found after this report is published. If so, then that material will be evaluated the same as the material reported here. Any additional useful information obtained after this report will be incorporated into the study and the project work plan modified accordingly.

The second part of this section poses the questions needed to identify the nature and extent of any water quality that may be present in Tillamook Bay that impacts any beneficial use of that water. The questions are divided into three groups:

(1) Problem Identification in the Bay and the tributaries,

(2) Source Identification in the Bay and the tributaries,

(3) Solutions to correct the problem, both technical and institutional.

The questions and answers are structured to report the results of judging the ability of each report or piece of data (mentioned in the first part of this section) to answer the question. A summary statement is provided at the end of each group of questions to aid the reader in understanding the conclusions and project needs reported in the final section of this background report.

A literature review, not specific to Tillamook Bay, but pertinent to the subject of shellfish sanitation, bacteria sources, bacteriological examination of service waters, and plans to control bacteria contaminated waste was also conducted. No discussion of the information is made here but the reader can refer to Appendix R for a list of documents reviewed.

Part I-- Report Identification

Fisackerly, George M. 1974. Tillamook Bay Model Study, Hydraulic Model Investigation. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

A study conducted in 1970-71 to verify accuracy of a fixed-base model of Tillamook Bay and the associated jetty. Model was used to verify an analytical study of the spacing of the proposed south jetty at the enterance to Tillamook Bay, relative to the existing north jetty. Data presented includes water velocities and salinities at various sample stations and at various water depths for the model and actual Tillamook Bay. The stated conclusions in the report are in regards to optimum jetty placement. The report is useful in showing horizontal and vertical salinity gradients in the bay. The number of sample stations limits the usefulness of this report to construct salinity gradients at various tide cycles. This information is needed in determining Tillamook Bay circulation patterns.

Slotta, L. S., D. R. Hancock, K. J. Williamson, C. K. Sollitt. 1974. Effects of Shoal Removal By Propeller Wash, December 1973, Tillamook Bay, Oregon. U.S. Army Corps of Engineers, Portland, Oregon.

A study conducted in December of 1973 to determine possible impacts of the agitation dredger LCM SANDWICK operations upon the estuarine system of Tillamook Bay Oregon. The report presents the water quality data for various stations in the lower bay at pre-dredging and during dredging times. No bacteria data is reported. Pre- and post-dredging animal data is also presented. Circulation patterns using dye were reported for the lower bay for Miami Cove to the bay entrance. The conclusions reported are in the terms of dredging operation impacts on the water quality and biological community in addition to the economic justification for dredging the channel to Garibaldi. The water quality data is useful but limited to the lower bay region of Garibaldi. Salinity data can help construct horizontal and vertical salinity gradients for the lower bay. The report provides adequate circualtion pattern information for the lower bay from Hobsinville Point to the bay entrance (See Plate 5).

Osis, Laimons and D. Demory. 1976. Classification and Utilization of Oyster Land in Oregon. Oregon Department of Fish and Wildlife, Portland, Oregon.

Purpose of the study was to "investigate and classify state lands that are suitable for oyster cultivation" at the direction of the 1969 Oregon Legislature. This report classifies each major Oregon estuary as to their potential for oyster production. "Existing leases are noted and potential growing areas and culture techniques are outlined. State Health Division restrictions and conflicting uses in each estuary are noted. Each estuary is rated low, moderate or high risk oyster growing area. The rating is a judgment value. A map of each estuary is provided showing pertinent data features."

The introduction of the report also states "State Health Division oyster growing area restrictions are based on potential health hazards such as sewage treatment outfalls, runoff from pasture land and marinas." It states that a two or more inches of rainfall in 24 hours closes estuaries to commercial shellfish harvesting because of increased and unacceptable bacteria levels. The report continues by saying "The bacterial counts usually decrease within 48 hours." This report is useful in determining specifics about the oyster industry in Tillamook Bay. It attributes the bacterial problems in Tillamook Bay during heavy rains to "numerous dairies." The report also mentions heavy recreation use in the lower bay by "clamers, crabbers, and anglers and heavy boat traffic in the main and south channels." Appendix B gives information reported for Tillamook Bay.

Bottom, Dan and Brent Forsberg. 1978. Federal Aid Progress Report Fishes: The Fishes of Tillamook Bay. Oregon Department of Fish and Wildlife, Portland, Oregon.

Reports research conducted in Tillamook Bay from May 1974 to November 1976 on the species composition and distribution of fishes in the bay. Purpose of the study was to provide "basic biological information relevant to planning and management of Tillamook Estuary." Conclusions reported are relative to the purpose of determing the numbers and varieties of finfish and not shellfish. However, the report is useful in providing basic information on seasonal temperature and salinity, and the physical make-up of Tillamook Bay. A portion of the data from this work was reported prior to the completion of the study. The report by Forsberg, B. O., J. A. Johnson and S. M. Klug, 1975, Identification, Distribution and Notes on Food Habits of Fish and Shellfish in Tillamook Bay, Oregon. Oregon Fish Commission, Portland, Oregon also describe oyster and clam distribution and production in the bay. This information was used to generate Plate 5 in this background report. Raw temperature-salinity data by station generated from this study was provided by Dan Bottom, Oregon Department of Fish and Wildlife to assist DEQ staff in determining circulation patterns in the bay.

Lauman, Jim, A. K. Smith, K. E. Thompson. 1972. Supplement To The Fish and Wildlife Resources of the North Coast Basin, Oregon and Their Water Requirements, April 1968. Oregon State Game Commission, Portland, Oregon.

This report supplies basic information on the Basin's fish and wildlife resources as they pertain to recreational and economic considerations. Abundance and distribution of fish and wildlife including stream flows at selected times are reported. No conclusions are drawn other than a strong recommendation to set suggested stream flows to ". . . protect Basin's fish and wildlife resources and water connected recreation and insure that future water rights are appropriated only in the best interest of all natural resources." This report is useful in providing information on the shellfish populations and recreation and commercial pressure placed on the finfish and shellfish resource in Tillamook Bay and its tributaries.

U.S. Department of Agriculture, Soil Conservation Service. 1978. Tillamook Bay Drainage Basin Erosion Sediment Study, Oregon, Main Report. Portland, Oregon.

The study, starting in 1973, was done to propose methods of reducing sediment in Tillamook Bay. The study produced three separate documents: a brief nontechnical summary, the main report and an appendices containing numerous tables on erosion and sediment input and output data. Conclusions drawn pertain to the level of treatment and methods to reduce the erosion-sediment problems in the bay and its watershed. The document has many very useful maps, hydrologic response determinations, and land use/land cover calculations broken down by major subbasins and bay.

Benoit, Clifford. 1978. Hydrologic Analysis For Forested Lands Tillamook Basin. U.S. Department of Agriculture, Forest Service, Portland, Oregon.

This document is a companion to the Soil Conversation Service Tillamook Bay Basin Erosion Sediment Study. It is restricted, though, to the forested lands of the basin. The report is written to characterize the existing hydrologic conditions on the forested lands. The report is useful in providing data and conclusions pertaining to the hydrologic response of the major subbasins in the project area.

Bowlsby, C. E. and R. C. Swanson. 1964. Soil Survey, Tillamook Area Oregon. U.S. Department of Agriculture, Soil Conservation Service, Portland, Oregon.

The document reports the results of a detail soil survey and mapping process for the lowland coastal areas of Tillamook County. The document is useful in determining soil characteristics and location of the soils in the lowland areas. However, specific soils determinations were not done on the forested regions of the county. This document is useful for determining drainage properties of the soils in residential areas of the project area but will not provide information needed for small groups of homes found in upper reaches of the Tillamook Bay watershed.

Kelch, William J., 1977. Drug Resistance, Source, and Environmental Factors that Influence Fecal Coliform Levels of Tillamook Bay. Thesis Oregon State University, Corvallis, Oregon.

Report of a water quality survey conducted in Tillamook Bay and its watershed during the rainy season of October, 1975 through March, 1976. Purpose of the study was to determine the source of bacteria in Tillamook Bay using bacteria resistance patterns to various antibiotics. Reported data is in a form needed to determine antibiotic resistance patterns and fecal coliform loading on the bay. The reported "major findings" are included in Appendix C. This report is useful in providing loading data and identifying factors which have a significant bearing on the bacteria loading of Tillamook

Bay. However, as was stated in the report, only a few sample sites were used which does not allow for more positive identification of bacteria sources.

Kelch, W.J. and J.S. Lee, 1978. Modeling Techniques for Estimating Fecal Coliforms in Estuaries. Jour. Water Poll. Control Fed. May, 1978: 862-868.

This is a report of the findings of Kelch's work initially reported in his thesis of 1977. (See previously summarized report by Kelch).

This paper is devoted to reporting the results of antibiotic resistance pattern determinations and regression analysis of fecal coliform isolations from Tillamook Bay during the rainy period of October, 1975 to March, 1976 (Appendix D). Most of the discussion is on regression analysis and building of a statistical model. The authors feel that antibiotic resistance parameters might be eliminated from models. They conclude that their system of screening large numbers of independent variables is more important than the model itself.

Kelch, W.J. and J.S. Lee, 1978. Antibiotic Resistance Patterns of Gram-Negative Bacteria Isolated from Environmental Sources. Appl. Environ. Microbiol. 36 (3): 450-456.

This paper reports the findings of water sampling that occurred during the same period as the Kelch thesis summarized above. The antibiotic resistance patterns are defined for fecal coliforms isolated from Tillamook Bay, some of its tributaries, and pastures adjoining the streams. Conclusions stated in the paper include: "These results strongly suggest that the antibiotic resistance patterns in these bacterial groups are very similar, perhaps indicating similar mechanisms for the development of this resistance, and also that the isolates were contributed by the tributaries and that, likewise, tributary isolates were contributed by runoff from the pastures."

Blair, T.P. and K.L. Michener, 1962. Sanitary Survey of Tillamook Bay and Sanitary Significance of the "Fecal" Coliform Organisms in Shellfish Growing Area Waters. Oregon State Board of Health, Portland, Oregon.

A study was carried out for approximately two years prior to the publication date of the report to determine the sanitary significance of fecal coliform organisms as it relates and correlates with total coliform organisms. Tillamook Bay was sampled for this study. A sanitary reconnaissance of the bay watershed was done but no water sampling results were reported other than general statements as to the problems and probable sources in each major river basin flowing into the bay. The results of this reconnaissance state the Miami and Kilchis Rivers are "relatively clean;" the Wilson River conditions, although not stated but implied, "is of major significance" because of the presence of human and domestic animal populations in this basin. The Trask is mentioned in passing but was not surveyed intensely like the three previously mentioned basins. The Tillamook River Basin is not discussed. Sewage treatment plants are mentioned as a major bacteria source when they do not operate properly. Coliform data for the bay samples is grouped by stations and is reported in a form to test the correlation of total coliforms versus fecal coliforms. The results state that "fecal coliforms more precisely defined pollution," and that "heavy runoff periods and low tides render high MPN levels." The data also reports the bay sample stations located near river mouths have higher counts than elsewhere in the bay, and that tidal conditions influence the bacteria concentrations. This is a very useful report because it is the earliest identified work that attempts to identify sources of the bacteria problems even though it speaks in generalities. The deficiency of this report in terms of usefulness by the Tillamook Bay Bacteria Study is that dates and individual sample results are not reported.

Westgarth, W.C., 1967. Tillamook Bay Study. Office Memorandum Oregon State Board of Health, Portland, Oregon.

Report of a study conducted in December, 1966, and in January, 1967 (Appendix E). Purpose of the study was to identify sources of the coliform bacteria that caused violation of coliform standards in Tillamook Bay. Bacteria data from the study is summarized in the memorandum "using flow-MPN values in breaking these down to percent contribution for each source." The only stated conclusion is, "From these data, it is evident that the treatment plants and suspected sewage sources contribute less that one-fourth of the MPN measured. The remaining three-fourths must stem from land runoff or domestic sources." Analysis of the study's raw data not reported but currently on file at the DEQ suggests (1) Patterson Creek is impacted by the urban area of Bay City, (2) Tillamook and Trask Rivers water quality being greatly impacted by land use activities below the forest-agriculture boundary, (3) Bacteria concentration in the rivers is dependent on precipitation and runoff, (4) The sloughs are being impacted by adjoining land use activities, (5) The STP's were not disinfecting the discharges, (6) Bay bacteria counts exceeding standards during the study with location of highest counts suggesting rivers as the source of bacteria.

Gray, C.H. 1971. Office Memorandum Bacteria Counts for Tillamook Bay. Oregon Department of Environmental Quality, Portland, Oregon.

Report of a study using available data in the Environmental Protection Agency's Water Quality Control Information System (STORET) computer system. Purpose of the study was to identify the median MPN value of bacteria samples taken in past years for each of the established Tillamook Bay sample sites. At the time of this study, 10 years of data was available to analyze. The memo includes copies of the data printouts which provides the opportunity for further analysis if desired. The calculations are made and applied to the Food and Drug Administration water quality standard at that time: 70 MPN median and not more than 10% of the samples shall exceed 330 (See Appendix E). Based on these calculations, the memo states: "Unfortunately, every station is in violation of the $\geq$330 MPN. However, two of the three stations located over the oyster beds are less than the 70 MPN standard. The west side of the bay which happens to be the farthest away from the river inputs indicates the lowest values, the only exception is Station 10."

Gray, C.H., 1972. Tillamook Bay Water Bacteriology Study. Oregon Department of Environmental Quality, Portland, Oregon.

A report of the findings of a survey conducted March 30 through April 5, 1972, which sampled Tillamook Bay, oyster meat from the bay, and the sewage treatment plants of Garibaldi, Tillamook Cheese, City of Tillamook, and the Port of Tillamook. Over the seven day sampling period, 13 samples per station were collected from the bay. Oysters from several locations were collected once per day and the STP's sampled every third day. The objective of the study was to determine water quality and oyster meat quality compliance with the established bacteriological standards. The study was conducted during measurable precipitation and "moderate" river flow conditions. Data is presented for temperature, conductivity, density/salinity, dissolved oxygen, BOD, total coliform, and fecal coliform. The summary and conclusions from the report are found in Appendix G. This is a valuable report in that the raw data is included in the report. This data demonstrates the conditions of the bay and STP's when the study area received 2.09 inches of intermittent rain in a seven day period. However, two weak points in the work stand out: (1) The bay samples were collected close to the time of high tide precluding a look at the low tide water quality when the bay may have more bacteria-laden freshwater in it, (2) The final conclusion that water quality of Tillamook Bay is satisfactory for oyster growing when, in fact, some of the stations in the bay violate standards in up to 46 percent of the samples taken. (See Appendix G).

Gray, C.H., 1973. Comprehensive Sanitary Survey of Tillamook Bay. Department of Environmental Quality, Portland, Oregon.

Report of a sanitary survey at Tillamook Bay conducted February 13, 1973. Objective of the study was to determine compliance of water quality standards established for growing and commercial harvesting of oysters. Sixteen samples were taken for each bay station. One sample per day from the STP's and one sample every three days taken from each of the five rivers which flow into Tillamook Bay. The study area received 1.06 inches of rain with a one day maximum of 0.67 inches and a one day minimum of 0.04 inches. There were three days without rain. The survey results report: (1) The bay sampling indicates acceptable levels of coliforms at five of the six stations. The station that violates, registered 84 coliforms/100 ml when the

Food and Drug Administration standard was 70 coliforms/100 ml. (2) "The sewage treatment plant data indicated much improved effluent results over last year's survey." (3) The river sampling data showed low coliform counts. The investigators found "lower than expected coliforms to fecal coliforms ratios" on the Tillamook and Trask Rivers. The report states "it is believed these were caused by cattle grazing in their respective watersheds." (See Appendix H). The stated conclusion of the results of the survey "indicated sampled portions of the Tillamook Bay to be acceptable for the growing and commercial harvesting of oysters." This report is useful because it provides the raw data for each sample taken. However, as in the Gray 1972 report, the bay samples were taken 4-7 hours before or after low tide even though the report states that samples taken on the low tide. Samples must be taken near the low tide to get a complete look at the bay conditions.

Oregon Department of Environmental Quality, Water Quality Monitoring for Oregon Streams.

The following discussion is a summary of data generated by the Oregon Sanitary Authority prior to 1969 and the DEQ for 1969 and after. No formal report of this data has been published covering this time period. A report by the DEQ Water Quality Division, Oregon Status Assessment Report is currently being written which analyzes water quality data in greater detail for the period of October, 1975 to present. The discussion here incorporates the Status Assessment Report conclusions. The data analyzed is the total coliform and fecal coliform values obtained from the Environmental Protection Agency's Water Quality Control Information System (STORET) which stores water quality information for Oregon streams. The period of record is 1960 to present. The STORET data includes sample stations and period of record for Wilson River Highway 6 bridge 1960 to present, Trask River Highway 101 bridge 1969 to present, Tillamook River at Bewley Creek Road bridge 1969 to present, Wilson River above and below cheese plant 1967, Miami River Highway 101 bridge 1979 to present, Kilchis River Highway 101 bridge 1979 to present, Wilson River Highway 101 bridge 1979 to present, Trask River Netarts Road bridge 1979 to present and Tillamook River at Netarts Road bridge 1979 to present. Only the Wilson Highway 6, Trask Highway 101, and Tillamook at Bewley Creek Road bridge sites had more than one water-year of data to analyze for trends. Prior to 1980, bacteria water quality standards for freshwater had not been established for streams entering Tillamook Bay. Brackish water portion of streams that were part of the estuary had a standard of 240 coliforms/100 ml. To provide some means of observing the stream data presented here, which are not part of the estuary, a hypothetical standard value for coliform bacteria of 1,000 coliforms/100 ml. is applied. This value is based on the Columbia River bacteria water standard of the same value. Since January of 1980, a standard of 200 fecal coliforms/100 ml. of sample has been in effect for freshwater and estuary waters, other than shellfish growing waters. The same standard, although not applicable before

1980, is also applied to the same stream data here to give a more complete look for the purpose of identifying trends. Data derived from routine ambient monitoring does not show cause-effect relationships nor is it designed to do so. Ambient data is designed to give an indication of water quality status and trends over time if enough and regular sampling of a station occurs. Trend analysis consisted of calculating the percent violations occurring at each sample site by year (See Appendix J, Figures 1-3) and by month for (See Appendix J, Figures 4-6) all years reported. The percent violation value is determined by calculating the number of coliform samples (out of the total number of samples for that month or year) that were above the 1,000 coliforms/100 ml. or 200 fecal coliforms/100 ml. values. The results of this trend analysis show that the past infrequent and irregular sampling schedule make year to year trend analysis difficult. What is more important to note is that the Wilson River site, located above most concentrated human and animal populations, does not reflect a high frequency of violations. Whereas, the Trask and Tillamook sites do, which are amongst concentrations of humans and animals. According to the data, the time of the year does not make a difference on the rate of violation for the Trask and Tillamook, but the dryer summer months do have an effect on the Wilson site. The January values for the Trask and Tillamook graphs reflect one sample taken on a dry day during the drought year of 1977 and may not be considered representative. The irregularity and infrequent sampling and the lack of basin coverage by sample sites makes it difficult to draw conclusions with any confidence. What does come out of this data is that high bacteria counts do occur in the rivers and these may or may not be associated with a weather event or high river flows. The placement of sample sites low in the watersheds, such as that being done in the 1979-1980 ambient network (See Appendix J, Table 1) will give more useful data for the present project and future trend analysis.

Oregon Department of Environmental Quality, Water Quality Monitoring for Oregon Bays.

The following discussion is a summary of data contained in the Environmental Protection Agency's Water Control Information System (STORET) which stores water quality information for Oregon bays generated by the DEQ for the period of 1970-1979. No formal report of this data has been published although a report by the DEQ Water Quality Division, Oregon Status Assessment Report, is currently being written to analyze the same data reported here. Figures and tables contained in this background report (Appendix K) are taken from that status assessment report. Prior to 1980, the bacteria water quality standards for Tillamook shellfish growing waters were: median coliform concentration not to exceed 70 organisms/100 ml. In January, 1980, the standards were further refined to state: a fecal coliform median concentration of 14 organisms per 100 ml. Both of these standards are applied to the data by year and by month of all years (Figures 1-5, Appendix K). The data is further segregated by grouping bay stations according to their close proximity to oyster growing areas and channel area stations. The purpose of this exercise was to define the quality of the water over the oyster beds. This is a significant exercise although this segregation ignores the presence of clamming areas associated near the "channel" station and therefore could lead to erroneous conclusions about the bay's compliance with water quality standards. According to the data presented here, yearly trends were difficult to discern. This was due primarily to (1) variations and sampling frequency and coverage and (2) the fact that the bay water quality is highly susceptible to storm events during which the bay water may or may not have been sampled. These problems are inherent in an ambient routine water monitoring program which is not designed to identify cause-effect relationships. The data also shows that the bay does violate standards under certain conditions and that these conditions occur more frequently during the wet months of the year. Linear regression analysis for the DEQ bay data for the 1970-1979 period was done on selected bay stations to determine the correlations between salinity, temperature and Wilson River flows versus bay fecal coliform levels. The results of this analysis (Table 2, Appendix K) shows that no clear correlation is apparent. What is also apparent is that high fecal coliform counts occur during wet weather periods as opposed to the dry weather periods, especially at station 14 located in the mouth of the Trask and Tillamook Rivers indicating that the source of contamination is coming from the river subbasins.

Tillamook County, 1979. Tillamook County Comprehensive Plan (Draft). Tillamook County Planning, Tillamook, Oregon.

Draft of the County's Comprehensive Plan Surface Water Quality Section. This section describes the quality of the water based on information provided by their staff personnel and other governmental agency staff. In the discussion of coliform bacteria conditions, they state, "Even though the major domestic waste sources in the county are treated and adequately disinfected, the in-stream and estuary coliform concentrations rise disproportionally to all expectations." The plan goes on to discuss possible sources of bacteria as runoff from cattle pastures during high runoff, and large herds of resident wild game (e.g., coastal elk and beavers). The discussion concludes with, "There is no indication that all of these animal bacteria are of any particular public health significance in the waterways but their presence is detected in the monitoring programs and published as violations of standards." The plan is useful in identifying the local perspective as to the causes of the high coliform counts.

Food and Drug Administration, 1975. Comprehensive Sanitary Survey of Tillamook Bay, Oregon, in November 1974. Northeast Technical Services Unit, Davisville, Rhode Island.

A report of the findings of a comprehensive sanitary survey of

Tillamook Bay, Oregon and its tributaries conducted November 11 through November 18, 1974. The objectives of the survey were "to determine the sanitary significance of indicator bacteria in shellfish growing waters, and to evaluate the overall pollution attributes affecting Tillamook Bay." Reported data includes bacteria counts for bay stations, tributaries stations, wet weather versus dry weather bacteria counts, sewage treatment plant sampling, oyster meat sampling, and probability plots for coliform data. Data also includes time-distance measurements for STP discharges, and low and high tide isohalines plots. The summary and conclusions from this report are reproduced in Appendix L. The most notable conclusion is that the sewage treatment plants and dairy herds are contaminating the bay and its tributaries and that this contamination occurs regardless of season, weather, or tide conditions. This report is the most definitive study of Tillamook Bay and its tributaries for that time period. The additional data and discussions about tidal ranges, dilutions, and other physical actions of the watershed will be helpful in the Tillamook Bay Bacteria Study.

Stott, R.S., 1975. Oregon State Shellfish Sanitation Program Review 1974-1975. Food and Drug Administration, Region X, Seattle, Washington.

A program review of the Oregon Shellfish Sanitation Program. No field sampling was done or data presented. The report highlights the progress and problem areas of the Oregon program by relying on previous studies available to FDA. Appendix M provides the points of discussion pertinent to Tillamook Bay. This report points out that (1) FDA was concerned about the pollution caused by sewage treatment plants and wet weather conditions and (2) FDA was also concerned about the minimal sampling effort during wet weather that was being done.

Food and Drug Administration, 1976. Tillamook Bay, Oregon, Pollution Source Evaluation with Classification and Management Consideration, May, 1976. Northeast Technical Services Unit, Davisville, Rhode Island.

The report of the findings of a survey of Tillamook Bay and its tributaries conducted May 18-24, 1974. The purpose of the study was "to reevaluate the pollution sources which affected the shellfish growing area water quality in Tillamook Bay and to determine if the recommendations for classification as set forth in the report, ,Tillamook Bay, Oregon Comprehensive Sanitary Survey, November, 1974,' were still applicable." Water sampling included bay stations, tributary stations, oyster meat, sediments, and sewage treatment plants. Raw data and summaries of this data are included in the report. The study was conducted during dry weather with reduced stream flows and low sewage flows from the STP's. Appendix N contains the summary, conclusions and recommendations from the study. FDA found that during dry weather the sewage treatment plants work properly and that fecal material from dairy cattle is "constantly introduced into Tillamook Bay via streams and sloughs" and is "diluted sufficiently to allow shellfish harvesting." The report also mentions that this fecal material is washed from pasture areas and fields into streams and sloughs that feed Tillamook Bay. This is a helpful report in that it establishes dry weather conditions for the project area. It further points out areas of bacteria contamination of the streams but does not specifically sample potential bacteria source operations, such as streams running only through a pasture or through housing developments.

Food and Drug Administration, 1978. Tillamook Bay, Oregon Sanitary Survey of Shellfish Waters, Nov.-Dec., 1977. Northeast Technical Services Unit, Davisville, Rhode Island.

A report of the findings of a survey of Tillamook Bay and its tributaries conducted November 30 to December 13, 1977. The purposes of the study were "to evaluate the continuing effectiveness of operation of the five waste treatment facilities discharging into the bay and to determine the effectiveness of runoff from areas highly polluted with cattle on tributary streams." The study was conducted during an "extremely wet period" which curtailed sampling on two separate occasions due to flooded roads. Water sampling included bay, stream, oyster meat, and sewage treatment plants. Raw data and summaries are included in the report. Appendix O contains some of the summaries. A great deal of effort also went into a sewage treatment plant operation evaluation including effluent chlorine residual monitoring, effluent bacteria monitoring, and STP reliability predictions. The most important findings were (1) that septic tank failures, farm animals (including dairy cattle) and sewage treatment plants contributed to the pollution problem in the streams (2) that the STP's did not meet a number of the facility operating requirements set forth by the National Shellfish Sanitation Program to provide reliable treatment of sewage and (3) that the bay was open to commercial oyster harvesting when the bacteriological quality of Tillamook Bay exceeded the recommended bacteria standards for shellfish harvesting and (4) the same conclusions were reached as in FDA's 1974 (1975 report) and 1976 studies as to causes of bacteria pollution. This is a helpful report if one wants to identify potential bacteria sources in the project area. There is no better time to find contributing sources than in a stress situation such as a flood. However, some question has to be made about the usefulness of the data for these levels of pollution since the storm sampled was considered to be an extreme situation. "FDA however, does try to place in perspective the significance of the cumulative rainfall during the study period as compared to other storm events of 2, 3, 4, and 5 consecutive days. The historical rainfall records show that substantial amounts of precipitation on consecutive days occur with the frequency of slightly more than once every other year."

State of Oregon, 1978. Oregon Shellfish Sanitation Task Force, 1978, Report and Recommendations. Oregon State Health Division, Portland, Oregon.

Report of the findings of a task force composed of industry and government agency personnel that was formed to deal with the problem of a struggling shellfish sanitation program and its problems with Tillamook Bay. The report makes recommendations with supporting comments and documentation (Appendix P). By the recommendations made, the task force concerned itself with the condition of the sewage treatment plants and identifying bay closure and opening conditions through a better water quality monitoring effort.

Stott, R.F., 1978. Oregon State Shellfish Program Evaluation 1977-1978. Food and Drug Administration, Region X, Seattle, Washington.

A program review of the Oregon program. This particular year's evaluation dealt with commenting on the Oregon Shellfish Sanitation Task Force Report (discussed above). The report takes each Task Force recommendation in turn and gives FDA's position on each statement. Appendix Q presents FDA's comments and is presented here in its entirety since it is considered to be the FDA position statement at that time.

Part II-- Questions--Problem Identification

The following reports were determined to have subjects pertaining to the question that is posed below.

1. Are there high bacteria counts in the bay? Do they violate the bacteria standards set for shellfish sanitation?

Osis & Demory, 1976:	Yes, the high counts exist, especially after a two or more inch rainfall closes the bay to harvesting.
Kelch, 1977:	Yes, suggest high bacteria loading in the bay which causes problems for sanitary harvesting of shellfish.
Kelch & Lee, 1978: (Modeling)	Yes, even suggest that bacteria are coming from tributaries running through pastures.
Blair & Michener, 1962:	Yes, suggest the cause is high runoff and low tides.
Westgarth, 1967:	Yes, but raw data not reported.
Gray, 1971:	Yes, using ten years of data shows frequent violations of the 70 MPN/100 ml. standard.
Gray, 1972:	No, for the period sampled according to the investigator. However, further analysis of the data shows that some stations in the bay violated standards up to 46% of samples taken.
Gray, 1973:	No, for the period sampled. Although, samples were not taken on the low tide.
Oregon DEQ Monitoring Data:	Yes, under certain conditions that occur more frequently during the wet months.
Tillamook County, 1979:	Yes, said counts are higher than expected.
Food and Drug Administration, 1975:	Yes, says that bay is contaminated regardless of season, weather, or tide conditions.
Food and Drug Administration, 1976:	No, a dry weather sample study with sufficient dilution in the bay.
Food and Drug Administration, 1978:	Yes, especially during flood conditions.

Shellfish Sanitation Task Force, 1978:	Yes, based on previous studies.

2. Are there high bacteria counts in the tributaries to the bay? Do they violate the fecal bacteria standards set to protect beneficial uses of the water?

Osis & Demory, 1976:	Yes, attributes some of the bay coliform counts to the tributaries. Does not judge counts against bacteria standards.
Kelch, 1977:	Yes, bay loading is caused by the tributaries. Does not consider fecal bacteria standards.
Kelch & Lee, 1978: (Antibiotics)	Does not answer question although report states that isolates from the bay were coming from the tributaries.
Blair & Michener, 1962:	Does not address the question directly although suggest high counts in the bay are coming from the tributaries.
Westgarth, 1967:	Yes, after analyzing the raw data not provided in the report. The report does suggest that 3/4 of the bay loading must stem from land runoff.
Gray, 1971:	Does not address the question specifically but does state in the conclusions, "The west side of the bay, which happens to be the farthest away from the river inputs, indicates the lowest values. The only exception is Station 10."
Gray, 1973:	No, river data showed low coliform counts.
Oregon DEQ Monitoring Data	Yes, depending on the seasons and precipitation amounts. Data is compared to hypothetical and established fecal bacteria standards.
Tillamook County, 1979:	Yes, said that counts are higher than expected but are not compared to the established fecal bacteria standard.
Food and Drug Adminsitration, 1975:	Yes, but does not compare to the standard. The report only demonstrates that high total and fecal bacteria counts occur in the tributaries.

Food and Drug Administration, 1976:	Yes, even in dry weather. Fecal material is "constantly introduced into Tillamook Bay via the streams and sloughs."
Food and Drug Administration, 1978:	Yes, especially during flood conditions. It shows extremely high counts in some small streams.

3. What is the bacterial quality of the waters over the shellfish beds?

Osis & Demory, 1976:	Only concerns itself with the oyster beds in the bay but says that the growing areas are restricted by potential health hazards such as treatment outfalls, runoff from pastureland, and marinas.
Bottom and Forsberg, 1976:	Does not address itself directly to the question. However, the report identifies the shellfish growing areas including clams. From this report it appears that the Tillamook Bay Bacteria Study should not segregate bay stations by shellfish growing areas due to the ubiquitous distribution of the shellfish growing areas in the bay.
Kelch, 1977:	Does not address the questions specifically but suggests that the high bacteria loading in the bay causes problems for sanitary harvesting of shellfish.
Blair & Michener, 1962:	Samples the bay but does not attempt to delineate shellfish growing area stations from the rest of the bay stations.
Westgarth, 1967:	Samples the bay but does not segregate shellfish growing area stations.
Gray, 1971:	Identifies the bacteria quality of the water over the oyster beds but ignores the clam beds. Bacteria levels do not violate standards in two of the three stations over the oyster beds.
Gray, 1972:	Segregates the oyster bed station and states that the total coliform counts were below the median 70 MPN standard.
Gray, 1973:	Bay samples were taken from stations in and around the oyster beds. Results indicate "acceptable levels of coliform at five of six stations." The one station in violation "just barely exceeds the Food and

Drug Administration standard of 70 coliforms/100 ml."

Oregon DEQ Monitoring Data:	When the bay data is segregated by location of sample station, the bacteria quality of the oyster stations is not as severe as the rest of the bay.
Food and Drug Administration, 1975:	No attempt was made to segregate station data according to location of oyster or other shellfish beds. Data is presented so that the reader, knowing where oysters are located, can segregate the data. This process demonstrates acceptable oyster bed water quality for this study.
Food and Drug Administration, 1976:	No attempt was made to segregate station data by location of shellfish beds. Data is presented so that the reader, knowing where oysters are located, can segregate the data. This process demonstrates some stations with and some stations without acceptable oyster bed water quality for this study.
Food and Drug Administration, 1978:	No attempt was made to segregate station data by location of shellfish beds. Data is presented so that the reader, knowing where the oysters are located, can segregate the data. This process demonstrates unacceptable oyster bed water quality for this study.
Shellfish Sanitation Task Force, 1978:	Does not specifically address the question, although the report's supporting data shows DEQ sample sites over the oyster beds violating standards in two to three of the six samples reported.

4. Under what conditions do the bay and tributaries violate the standards? Is the magnitude of the violations dependent upon time of the year or weather?

Osis & Demory, 1976:	Violations are dependent on the amount of rainfall. Magnitude of violation is not discussed.
Bottom and Forsberg, 1978:	Times of high flow in the rivers cause low salinities in the bay. From this report it is assumed that if this fresh water is bacteria-laden, then the bay will violate bacteria standards.

USDA-SCS, 1978:	From this report it is assumed that if bacteria levels are a function of runoff, then those land areas with a high runoff potential will contribute available bacteria to the watershed. Magnitude of violation would depend on amount of bacteria available to run off and the amount of runoff that occurs.
Benoit, 1978:	The same conclusions as the USDA-SCS, 1978, report above.
Bowlsby and Swanson, 1964:	From this report, assuming that soils that drain poorly will saturate rapidly, and combined with the conclusion of Hagedorn, et al. (Survival and Movement of Fecal Indicator Bacteria in Soil Under Conditions of Saturated Flow, J. of Env. Qual. 7(1):55-59) that bacteria move at the same rate as water moves through saturated soil, one may draw the conclusion that saturated soils with high bacteria counts will contribute bacteria to streams if the groundwater is intercepted by a ditch or stream. The magnitude of the contribution would depend on the availability of bacteria in the ground.
Kelch, 1972:	The bacteria counts fluctuated by month with the highest counts occurring after heavy rainfall.
Blair & Michener, 1962:	The report states "heavy runoff periods and low tides render high MPN levels." Magnitude of violations are not discussed.
Westgarth, 1967:	Question not addressed in the report but drawn from the data, is the conclusion that bacteria concentration in the rivers are dependent upon precipitation and runoff.
Gray, 1972:	Bacteria standards violations occur during rainy periods. Magnitude of violations are not discussed.
Gray, 1973:	Rain occurred but bay samples did not violate bay standards except in one case. That site violated the standard after rainfall. Some tributary stations also violated guidelines after rainfall. Magnitude of violations are not discussed.

Oregon DEQ Monitoring Data: The results of linear regression analysis of the data, although not clearly defined, suggested that the standards are violated frequently during wet weather. Magnitude of the violations appear to be dependent upon the amount of rainfall.

Food and Drug Administration, 1975: Bacteria contamination of the streams and bay occur regardless of season, weather, or tide conditions. Magnitude of the violations are dependent upon the amount of precipitation.

Food and Drug Administration, 1976: The study occurred during dry weather. This data combined with the two other FDA studies demonstrates that bacteria levels are related to rainfall amounts.

Food and Drug Administration, 1978: The report states that "during wet weather, Tillamook Bay oyster waters are polluted with fecal waste." It also states that 13 of the 17 tributary stations ". . . had water quality comparable to that found in the estuary." The report did not specifically discuss the rainfall amount vs. the amount of bacteria in the waters.

5. <u>How quickly do the bay and tributaries violate the standard?</u>

Osis & Demory, 1976: The report states that two or more inches of rainfall will close the bay to shellfishing.

Bottom and Forsberg, 1978: Seasonal salinity patterns in the bay suggest the high-low seasons of rivers will have an impact on how quickly the watershed will violate standards when it rains.

USDA-SCS, 1978: Hydrologic response maps suggest that portions of the bay watershed have a rapid runoff response. If the bacteria levels are a function of runoff, then the rivers will violate standards rapidly.

Benoit, 1978: Hydrologic response of some forested areas is rapid, suggesting if the bacteria sources are present, then the rivers will violate the bacteria standards rapidly.

Bowlsby and Swanson, 1964: The report notes some poorly drained soils which, if bacteria sources are present on the soils, will give a rapid standards violation when rainfall occurs.

Gray, 1973: Response time not specifically discussed but data shows that bay bacteria levels do respond within 24 hours of a rainfall. Further definition of response time was limited by the fact that precipitation start times are not reported.

Oregon DEQ Monitoring Data: Question not specifically addressed but using precipitation data for 3-4 days prior to the sample time, one might be able to determine the response time for the bays and tributaries.

Food and Drug Administration, 1975: Suggest rapid response to rainfall which will cause standards violation.

Food and Drug Administration, 1976: Study occurred during dry weather.

Food and Drug Administration, 1978: The bay was violating the standards when sampling began. Tributary data showed variable levels of bacteria dependent on precipitation amounts. These results suggest a rapid bacteria level response to the rainfall.

6. <u>How quickly does the Bay flush itself of high bacteria levels?</u>

Fisackerly, 1974: The new jetty construction will not significantly change the tidal characteristic of the Bay. Based on this knowledge, any results of studies done prior to October, 1979 (jetty completion) will still be valid. The mean tidal prism of the bay is approximately 48,000 acre-feet. The Bay contains approximately 53,800 acre-feet of water at mean high tide (based on 14 sq. miles of surface area and 6 ft. average depth). Therefore on one complete tide cycle 89 percent of the water will be exchanged. This figure depends on the tidal range and river discharge rates.

Slotta, et al., 1974: Only studied the lower Bay area from the Bay mouth to Miami Cove. The report gave no useful information to develop an answer to the question.

Osis & Demory, 1976: The report states that the Bay is closed to shellfishing for at least 48 hours after a heavy rainfall.

Bottom & Forsberg, 1978: Does not address question directly. However, the report states "Tillamook Bay is probably well mixed to partly mixed most of the year, with large tidal amplitudes, shallow depths, and moderate freshwater inflow preventing maintenance of a two-layered system for extended periods". This would indicate that water agitation occurs regularly with the tidal cycles causing bacteria exchange to occur with the water exchange.

Food & Drug Administration, 1975: The study began the day after a seven-day period of rain totaling 3.43 inches. No rain occurred for approximately six days at the beginning of the study. Bay water sampling results showed that some areas of the Bay (primarily channel areas) were in violation of the standards at the beginning of the study and did not significantly clean up during the dry period. Other stations violated on the low tide and complied on the high tides.

Food & Drug Administration, Adminsitration, 1976: The study began after 0.31 inches of rain fell the day before. No appreciable amount of rain fell in the seven days prior to that time. Most Bay sample stations showed improvement of bacterial water quality within 48 hours of the last rainfall. Those stations not showing a marked improvement were near river discharge points.

Food & Drug Administration, 1978: It rained almost every day during this study. Bay stations violated the standards in all samples taken. Bacteria levels fluctuated with varying amounts of rain.

Bacteria level response times were usually 24 hours or less depending on sampling frequency.

7. What is the bacteria level in the shellfish meat when the water bacteria standard is being violated?

Gray, 1972: Oyster meat samples taken during the study indicated coliform counts below current FDA standards while most water samples taken over the oyster beds did violate standards. Other Bay sample sites did violate the bacteria water quality standard in up to 46% of the samples taken.

Food & Drug Administration, 1975:	The study showed extremely high oyster fecal coliform/water fecal coliform ratios.
Food & Drug Administration, 1976:	The study found low level fecal contamination of the oyster meat (compliance with oyster meat standard) occurred consistently with low level fecal contamination of the Bay water.
Food & Drug	While the Bay water continuously violated the water standard ". . . seven of the eight stations had half or more of the samples with fecal coliform values of 230 MPN or greater. Thirty-nine percent of samples had values greater than 230 MPN. Twenty-five percent of the 44 samples had values equal to 230 MPN."

Summary Statement for Problem Identification Questions

Based on the information provided by the reports reviewed above, the following conclusions can be drawn about the existence of a water quality problem in Tillamook Bay:

1) The Bay and sampled tributaries to the Bay rapidly violate bacteria water quality standards when it rains.

2) It appears that the Bay can violate the standards with less than a two inch rainfall. This is contrary to the Bay closure practice currently being used.

3) It is not known for certain as to the sources of the bacteria. Most likely they are located in the Bay tributary watersheds.

4) Oyster meat quality may or may not violate bacteria standards when there exists a water bacteria standards violation.

5) Clams are distributed throughout the Bay. A serious oversight exists when only oyster growing area water quality is considered.

6) It is uncertain as to how long it takes for the Bay waters to comply with the standard after a storm subsides.

Questions---Source Identification

The following reports were determined to have subjects pertaining to the questions that are posed below:

1. What are the sources and relative contribution of bacteria to the Bay and tributaries? Under what conditions do they contribute bacteria?

Osis & Demory, 1976: Report identifies ". . . numerous dairies and Tillamook Bay and runoff from pastures during heavy rainfall".

Klech, 1977: The report states that, "Bay fecal coliform levels were highly correlated with the fecal coliform counts of tributaries especially those of the Trask and Wilson Rivers, degree of resistance to antibiotics, recreational activities, and precipitation". The report also mentions wet pasture lands as a possible source. Sources would discharge during periods of precipitation.

Klech & Lee, 1978: (Modeling) Same conclusions as Klech 1977. Also mentions recreation in the area of Kilchis County Park as a possible source.

Blair & Michener, 1962: Mentions humans and domestic animals as major sources of pollution to streams. Discusses the lack of deep good soils for sewage disposal adding to the problem. Discusses the Wilson River as a major contributor of bacteria in the Bay. Mentions the sewage treatment of the cities and cheese factory. Potential sources include wild animals, picnic areas, and unsewered suburban areas.

Westgarth, 1967: Report states, "From these data it is evident that the treatment plants and suspected sewage sources contribute less than one-fourth of the MPN measured. The remaining three-fourths must stem from land runoff or domestic sources."

Gray, 1972: Identifies the Garibaldi and cheese factory sewage treatment plants as creating problems for the Bay quality.

Gray, 1973: Sources identified as possibilities were the sewage treatment plants and cattle grazing during rainy weather.

Tillamook County, 1979: The plan suggests runoff from cattle pastures and large numbers of resident wild game (e.g. coastal elk and beavers) and the possiblity of not adequately treated domestic waste sources.

Food & Drug Administration, 1975: "The predominant sources of pollution were sewage treatment plants and dairy herds". This occurs during wet weather and some of

	the data suggests ". . . feces from the cows also enter the tributaries even in dry weather".
Food & Drug Administration, 1976:	"The tributaries and sloughs were a constant source of fecal pollution into Tillamook Bay." Major pollution sources were identified as the five waste treatment facilities and fecal waste material from large numbers of dairy cattle constantly getting into the streams. Failing septic tanks also present a potential problem.
Food & Drug Administration, 1978:	Flooded septic tanks and leeching fields, dairy cattle, and other farm animals, and four of five waste treatment facilities were identified as sources of bacteria during the heavy rains.

2. <u>Do the waters from these Bay and tributary sources reach the shellfish areas?</u>

As was stated in the summary of the problem identification questions, all of the studies were concerned with the oyster growing areas and disregarded the clamming areas. Since these clamming areas are located throughout the Bay, any bacteria-laden freshwater reaching them would impact these beds.

As for impacts to the oyster beds the following reports are reviewed:

Fisackerly, 1974:	From the information presented, circulation pattern information is limited to the lower Bay which is below the oyster growing areas that includes clamming areas.
Slotta, et al., 1974:	The study was restricted to the lower Bay area of Miami Cove to the Bay mouth. This area is below the oyster growing areas but includes clamming areas.
Bottom & Forsberg, 1978:	Temperature-salinity data suggests most freshwater flowing through the Bay stays away from the oyster beds.
Benoit, 1978:	The report mentions that ebb tide water seems to flow along the east shore of the Bay with flood tide water flowing into the west area of the Bay.
Blair & Michener, 1962:	Data was segregated by channel area versus oyster growing area. Differences in the sample station data for one sample day

suggests that strong freshwater currents flow away from the oyster growing areas.

Gray, 1971: Difference in the oyster growing water quality and channel area water quality suggests most bacteria-laden freshwater flowing away from oyster areas.

Gray, 1972: Same conclusions as Gray, 1971. Report also mentions vertical stratification of freshwater and seawater occurring during part of the tidal cycle.

Oregon DEQ Monitoring Data: Segregation of data by oyster area/channel area, suggests that most of the bacteria-laden freshwater leaves the Bay via the easternmost one-third of the Bay.

Food & Drug Administration, 1975: This study produced time of travel studies for the sewage treatment plants in the Bay and its watershed. The study used drogues which are effected by wind direction and velocity. This study states, "The drogue work indicated that effluents from the nearby STP's and freshwater from major rivers reach approved shellfish growing areas in less than six hours. This is hardly enough time for adequate die-off of coliform bacteria". In addition to this work, the study also considered bacterial stratification. The stated results for the deepest Bay stations were, " The median values show that at the time of the study no substantial bacterial stratification existed in the area of the Bay where these stations were located. Therefore, it was concluded that the remaining Bay stations which, by contrast, were located in much more shallow water, would not exhibit significant bacterial stratification."

Food & Drug Administration, 1976: Refers to their study of 1974 and stated in the 1975 report. (See above)

Food & Drug Administration, 1978: This study did not address circulation patterns in the Bay although some time was spent discussing the impacts of large amounts of freshwater on the study's Bay and tributary salinity readings. The report suggest that the upper portions of the Bay (including some oyster growing areas) were mostly freshwater during the sampled storms.

The study also addressed salinity stratification. During the heavy runoff period the study states, "There was little stratification on these two days because of the large amounts of fresh water contributed to the estuary." At other times the study states, "A comparison of surface and bottom salinities reveals that generally there is a tendency for stratification between surface and bottom layers."

Summary Statement for the Source Identification Questions

Based on the information provided by the reports reviewed above, the following conclusions can be made about the sources of bacteria pollution in Tillamook Bay and their possible impacts to the shellfish beds:

1) Sources of bacteria pollution of the Bay are located in the tributaries and include dairy pastures, sewage treatment plants, recreational activities, unsewered suburban areas with failing septic tanks, and wild animal populations. Sewage treatment plants discharging directly to the Bay can also cause pollution.

2) Many of the reviewed reports are old. Sources, such as problems with sewage treatment plants, may have been corrected since the report identified them as a problem. Therefore, existing sources may not be the same.

3) A serious oversight by past work with the impacts of bacteria-laden freshwater on the clamming areas. The ubiquitious distribution of clamming areas demonstrates that "channel sample sites" should also be considered in the Bay water quality determinations for shellfish sanitation.

4) Freshwater circulation in the upper Bay is not well known. Questions still remain about bacteria-laden freshwater reaching the oyster growing areas.

5) The USDA studies mention high sedimentation rates and shifting sediment in the Bay. This fact raises questions as to present day validity of previous circulation pattern work.

Questions---Solutions to the Pollution Problem

1. Assuming that the Bay will always violate standards at the same time of the year and that shellfish harvesting occurs year-round, what physical parameter(s) that is easily monitored and gives a real-time result could the oyster harvesters use to determine bacteria levels in the growing waters?

No reports reviewed here address this question directly. However, some of the studies report raw data which provides a data base from which to possibly answer the question. From the reports, it appears that the Bay is very "flashy", violating bacteria standards and changing physical composition of the water (salinity, temperature, turbidity) within one tide cycle. If this is the case, then finding a good correlatable physical factor that can give a real-time water quality indication may be difficult. Further data analysis will be necessary.

2. What criteria (e.g. physical parameter, runoff condition, climatic condition, shellfish meat bacteria level) will open the Bay to harvesting? When do we start sampling after closure to determine when to reopen the Bay?

Because of the existing water quality standards for bacteria, the only criteria to use at the moment is the water bacteria standard. All studies reviewed based their conclusions on these standards. None of the reports suggest different criteria other than changing from a total coliform standard to a fecal coliform standard.

Depending on the outcome of the data analysis suggested in Question # 1 above, a physical parameter may be suggested in lieu of a bacteria sample. If so, then shellfish harvesting might begin sooner after a closure because of the lag time in processing bacteria samples.

The Oregon Shellfish Sanitation Task Force Report of 1978, had as one of its recommendations (Appendix P), "The OSHD must establish criteria for the closure and reopening of each shellfish processing activity and shellfish growing area based on water samples to cope with possible sewage treatment plant failure, introduction of toxic materials or the occurrence of other unacceptable water quality conditions". The report in the fourth recommendation states, "Upon Bay closure DEQ and OSHD will sample Bay waters for fecal coliforms and, if indicated Salmonella organisms." The sixth recommendation, "The OSHD will establish criteria for the closure and reopening of shellfish processing activity, based on the microbiological levels of the meat sample." These recommendations suggest that the Task Force was more acutely concerned with the immediate risk to public health posed by the contaminated food product than the potential health risk based on the water quality which may or may not, in real time, indicate the public health risk.

The Stott, Oregon State Shellfish Program Evaluation 1977-1978, comments on the Task Force recommendations on sampling the product meat instead of the water would not satisfy FDA's program requirements. Comment on the Task Force recommendation #6 about sampling the meat states (Appendix Q) that they do not agree with the recommended Task Force procedure because "The concept of determining suitability of a growing area by analysis of shellfish meats has never been endorsed by public health agencies since the development of the program in 1926." Although, in FDA's comments, they do ". . . . support analysis of both water and shellfish meat after a closure based on water quality and/or a situation of potential contamination."

3. <u>What are the options for control of identified sources discharging into the Bay or tributaries? To what level of control should these occur?</u>

Most of the reports that identify sources of bacteria imply that the problem should be corrected. But, they do not state to what level of control other than to imply that elimination of the contaminated discharge will allow standard compliance of the water.

The following reports give specific control options:

Tillamook County, 1979:	The plan states, "208 nonpoint source planning and orderly planning of municipal waste treatment capabilities should effectively return coliform bacteria counts to an acceptable level, thereby protecting future beneficial water uses."
Food & Drug Administration, 1975:	Recommends that the Bay be closed until growing areas are properly classified. If the Bay cannot be cleaned up, then continued shellfishing could continue by shellfish purification using "relaying" (moving shellfish to clean bays for a few days) or "depurating" (cleanse in holding tanks) the shellfish. No other control options were suggested.
Food & Drug Administration, 1976:	Suggests performance standards for each of the five sewage treatment plants based upon the amount of precipitation the area receives. A detailed description of each plant is provided that includes specific corrective actions to be taken. Other sources are considered but in terms of proper growing area classification.
Food & Drug Administration, 1978:	Discusses many aspects of sewage treatment plant performances and deficiencies as they relate to the protection of shellfish growing waters. The report lists the needed corrective actions for the STP's to meet the suggested performance criteria of an STP operating near shellfish growing areas.

Summary Statement for the Pollution Control Questions

Based on the information provided by the reports reviewed above, the following conclusions can be made about the options for control of bacteria pollution sources in Tillamook Bay and its watershed:

1) Everyone agrees that there is a bacteria pollution problem. But, not all reports suggest control options for nonpoint runoff such

as animals, and failing septic tanks. Some say control the opening and closing of shellfish harvesting in the Bay as a way of confronting the problem. Others give specific controls for correcting the pollution sources.

2) The physical makeup of the Bay causing rapidly changing conditions may make it difficult to have procedures to cover all types of precipitation, river discharge, and tidal conditions.

3) New, innovative and possibly very logical methods of monitoring the bacteriological conditions of the Bay may be difficult to establish. This is based on FDA's comments in reply to the Shellfish Task Force recommendations. These are policy and concept issues that have to be answered to produce an effective water quality management plan for Tillamook Bay.

CONCLUSIONS

From the data and studies reviewed in this report, the conclusion can be made that Tillamook Bay and some of its tributaries experience unacceptably high fecal bacteria levels that could hinder safe usage of the water by shellfishermen and water contact recreation users. According to these studies, this contamination can occur regardless of season, weather, or tide. The types of sources that can contribute but do not regularly contribute are sewage treatment plants, failing septic tanks, pasture application of animal waste, recreation, and wild animal population.

Also concluded from the data is the fact that the watershed and Bay present a very complex system to understand. There is a complex relationship between precipitation amounts, amount of soil moisture, amount of fecal material available to the drainage system, river discharges, and tide exchange amounts (to name a few) that will determine the fecal bacteria levels in the Bay at a particular moment. Usage of the water by humans and shellfish add another dimension to the already complex problem of determining when to control a bacteria source, how to control, and to what level of control should be applied.

A question was continually raised when reviewing these reports. "Are the results of the report being reviewed representative of today's conditions?" Some of the studies were done many years ago. The water quality data in them represented the conditions then. But do they now? The Bay and watershed are constantly changing character. Sediment builds up in the Bay changing circulation patterns, freshwater retention time, and the water exchange rates. People and animals come and go. They may move to new locations within the bay's watershed. New subdivisions are built. Sewage treatment plants are built or modified. Dairy farms change ownership and with them, a change in manure management philosophy and size of herds.

The data represented in the reports also has to be questioned. The DEQ data and some of the other studies did not define the weather conditions and river flows in which the samples were taken. Weather records and U. S. Geological Survey river flow data were helpful in filling some of the gaps. But these records are daily averages or maximums. Since possible fecal sources respond differently in different weather conditions, (in addition to the time it takes to respond) not knowing when the rains began or the river began rising makes it difficult to say from the report, with confidence, what was the source of the fecal contamination. For example, those reports identifying problems with animal waste contamination collectively identify dairy farming as a problem. They do not identify the type of farm operation or location of the source on the farm. Experience shows, that no matter what type of land use is considered, a collective statement pertaining to one land use as a source of pollution is usually erroneous. In other words, does the mere existence of a dairy constitute a pollution source?

A resource review of the study area conducted in the second section of this report suggests that not all fecal source types have been studied in the past. Recreation in a county park is the only type of recreation studied. Many other types of recreation occur today including camping, fishing, and off-road vehicle use. Boat basins, shoreline homes and houseboats, wild animal populations, forestry activities, and industrial sources have also been suggested but never studied to see if they actually contribute fecal material to the streams and bay.

In discussions with local citizens and government people, there is also disagreement as to how to solve the problem -- correct the source or control the usage of the water. Those who suggest controlling the usage of the water, do not consider all the uses of that water. Those who suggest control of the sources, demand or imply zero fecal bacteria discharge. Is that possible or economically feasible? The merits of each solution have not been carefully weighed in the Tillamook Bay area.

From the report reviews and discussions with local people, there are gaps in knowledge to what geographical extent the fecal contamination is occurring, what types of activities are creating the problem and how best to correct the problem. To fill these gaps and settle the disagreements the following is needed:

(1) Identification of existing conditions under various weather, season, and tide conditions which will aid in identifying the type, location, and conditions for fecal discharges of various source types.

(2) Determine the type, level and specific options of control necessary to alleviate the bacterial pollution problem.

(3) Determine the public perception of the problems and its causes. Since any effective control strategy to be implemented in an area needs public acceptance, people's perception of the problem and their suggested controls are needed.

If the Tillamook Bay Bacteria Study is able to satisfy these needs, then a management plan can be written, adopted, and implemented that will ensure the protection of the natural resource and beneficial uses and at the same time allow activities identified as sources of fecal contamination to continue to operate under a sensible management plan.

APPENDIX A.

State-Local Role

Local and State health departments in the coastal areas inspect and approve shellfish-growing areas and handling plants in accordance with procedures developed jointly by State and Federal Governments. Shellfish shippers awarded operating certificates by the State receive an identifying number which must be placed on every package of fresh or frozen oysters, clams, or mussels. Frequent FDA appraisal of State shellfish control programs insures their integrity.

Inland States benefit directly from the control programs carried on by the coastal States. For the information of these States, FDA publishes a list of the certificate numbers of all State-certified shippers. These lists, issued semi-monthly, should be used by State and local sanitarians to make sure that shellfish offered for sale are obtained from certified shippers in States whose programs are endorsed by the FDA.

Adulterated or mislabeled shellfish (contaminated, decomposed, etc.), if shipped in interstate commerce, are subject to seizure and shippers may be prosecuted or enjoined under the Federal Food, Drug, and Cosmetic Act administered by the Food and Drug Administration.

The entire shellfish control program is one of interlocking and joint cooperation by industry, States, and FDA, to assure that only safe shellfish are sold in the market place.

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

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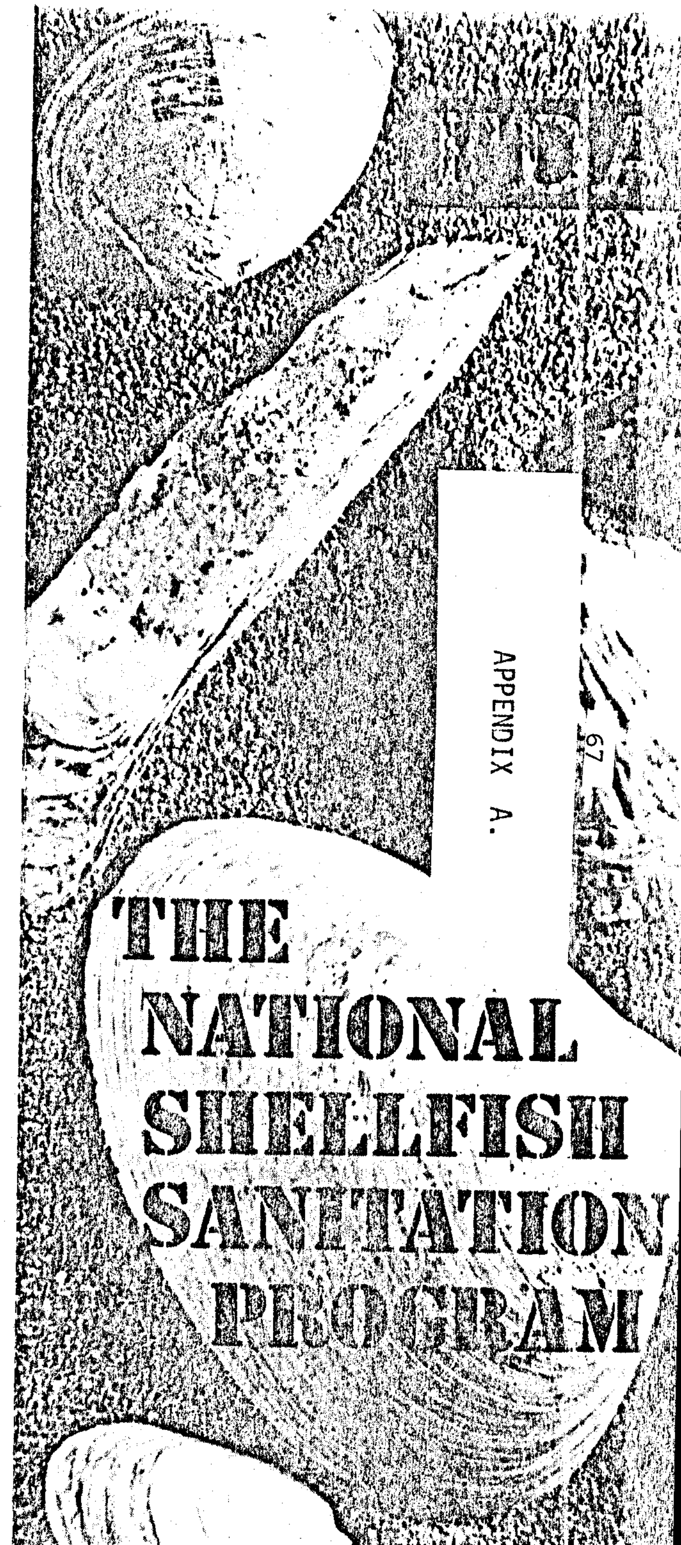


The SHELLFISH SANITATION Program of the Food and Drug Administration

Approximately 124,000,000 pounds of oysters, mussels, and clams are harvested annually in this country. A good sanitary control program is necessary to insure a safe and wholesome food product because shellfish grow in coastal waters which may become easily contaminated, and because some species are eaten raw.

How Shellfish Become Contaminated

Seafoods such as oysters and clams grow best in protected bays where fresh water runs off the land and mixes with salt water from the sea. Such bays have an abundance of microscopic plants and animals called plankton on which shellfish feed.

Unfortunately, some bays are polluted by sewage from coastal cities, industry, or private sewage systems, and the plankton may include harmful organisms. If harmful organisms or toxic chemicals are absorbed or concentrated in shellfish meats, this food product may be dangerous to eat. For this reason, shellfish harvesting is prohibited in areas contaminated by sewage. To enforce this prohibition, these areas are patrolled by State health or fishery agencies.

Initial Efforts at Sanitary Control

The relationship between contaminated waters and the safety of shellfish from these waters has been understood since the late 1800's. A variety of inspection and supervision methods were initially used to prevent use of such contaminated shellfish as food.

During the first 25 years of this century, health and fishery agencies attempted to combat disease transmission by shellfish through such measures as bacteriological sampling of shellfish, inspection of processing plants, and some inspection of shellfish-growing areas.

The Shellfish Sanitation Program Today

Since 1925, close and interlocking cooperation has existed between shellfish-producing States, the shellfish industry, and the Public Health Service. All operating controls are exercised by the States in accordance with established standards. The sanitary survey of the shellfish-growing areas is perhaps the most important aspect of the program. State health department or conservation personnel continually inspect and survey bacteriological conditions in all State shellfish-growing areas to determine which areas are safe to use.

State supervision of contaminated areas is also very important. Once shellfish have been taken from polluted waters, it is difficult to tell contaminated shellfish from completely safe ones. The only way to keep such shellfish off the market is to keep them from being harvested in the first place. Therefore, harvesting is restricted in all polluted waters. Warning signs are posted, and these areas are patrolled to prevent illicit harvesting.

State inspectors check shellfish harvesting boats and shucking plants before issuing the approval "certificates" which really constitute a State license to operate. Plants having approval certificates place a certification number on each package of shellfish shipped. The number indicates the shipper is under State inspection, and that he meets the requirements of the cooperative program. It also serves another important purpose. In the rare event of accidental contamination, it becomes easier to trace and stop any offending shipments.

Recently, shellfish sanitation experts have become concerned by the apparent ability of shellfish to concentrate radioactive material, insecticides, or other chemicals from their environment. To meet these problems, health officials are gradually expanding their efforts to provide adequate protection against these dangers, just as they have earlier provided protection against harmful microorganisms and marine poisons.

Shellfish Toxins: Another Problem

There are two broad phases to the shellfish control program. The first is related to sanitation; i.e., the freedom of shellfish-growing areas from sewage pollution or toxic industrial waste. The second is related to natural toxicity. The poison which causes paralytic shellfish poisoning is found in planktonic organisms known as dinoflagellates. Survival and multiplication of these organisms are apparently not dependent of food supplied by sources of pollution such as sewage. Therefore, the control of toxicity is not directly related to sanitation.

Fortunately, with the exception of Alaska, and to a lesser degree the West Coast and New England States, the control of shellfish toxicity is not a major problem in the United States. Control is achieved by careful examination of growing areas, and the prohibition of shellfish harvesting from areas in which the shellfish are highly toxic.

Food and Drug Administration's Part

A continuing review of State shellfish control programs, including inspection of a representative number of shellfish processing plants each year, is made by FDA personnel. On the basis of information obtained, the FDA endorses, or withholds 68 endorsement, of each State program. Twice a month, the FDA publishes a list of valid interstate shipper permits issued by State shellfish control authorities with FDA-endorsed programs. The FDA also has many other program responsibilities, including the development of new standards, research, provision of technical assistance, and training for Federal and State shellfish sanitation workers.

The Shellfish Industry's Part

The shellfish industry cooperates by obtaining shellfish only from safe areas, by maintaining sanitary conditions in their plants, and by placing certificate numbers on all packages of shellfish shipped. Records showing origin and disposition of all shellfish handled must also be kept by each shipper, and made available to control authorities. Thus, continuing sanitary control of shellfish is a joint responsibility of the individual shipper, the industry, and the State and Federal Governments.

APPENDIX B.

CLASSIFICATION AND UTILIZATION OF OYSTER LANDS IN OREGON

Informational Report No. 76-7

by

Laimons Osis
Darrell Demory

September, 1976

TILLAMOOK BAY

EXISTING OYSTER LEASES

Grower	No. Acres Leased	No. Acres in Production
Hayes	1687.00	700
Harris	199.24	75
Olson	197.90	174

POTENTIAL OYSTER CULTURE AREA

The potential oyster culture area extends from Hobsonville Pt. upbay to a line drawn between the Bay City Pier and Dick Point (3,300 acres).

POTENTIAL OYSTER CULTURE TECHNIQUES

Bottom, raft, rack and stick culture may all be feasible, depending on the exact area.

PHYSICAL LIMITATIONS OF OYSTER CULTURE AREA

Winter heavy freshwater runoff results in reduced salinities, strong currents, and heavy silt load in the area. Soft mud restricts bottom culture in some areas.

CONFLICTING USES AND PROBLEMS OF OYSTER CULTURE AREA

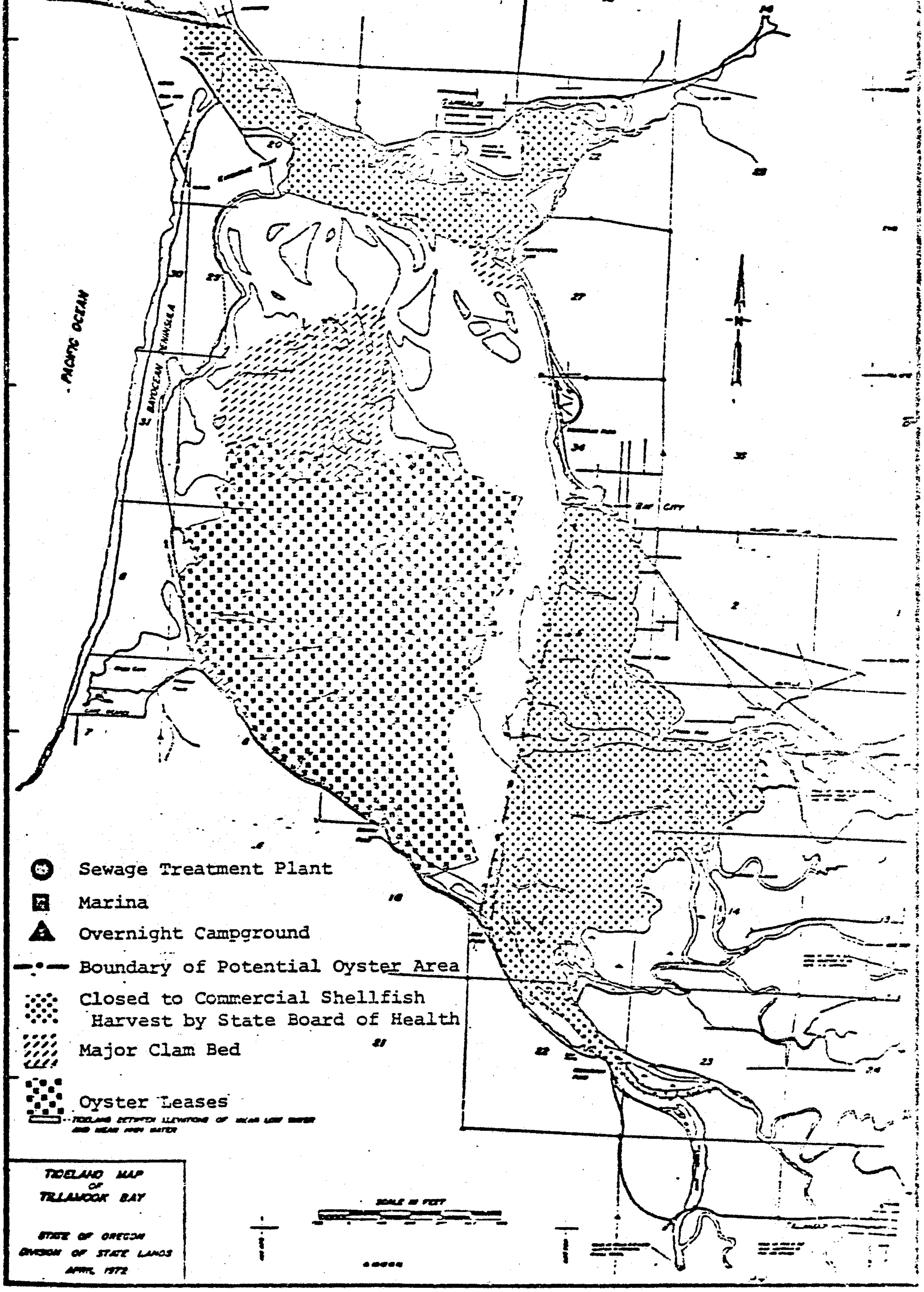
There are State Health Division closures on the commercial harvest of shellfish in two areas: north and seaward of a line drawn from Hobsonville Point across the bay to Kincheloe Point and upbay from a line drawn between the Bay City Pier and Dick Point.

There are numerous dairies around Tillamook Bay and runoff from pastures during heavy rainfall sometimes results in very high coliform bacteria counts in the bay. It is then closed to shellfish harvesting for at least 48 hours.

There is a heavy recreational use of the lower bay by clammers, crabbers and anglers, and heavy boat traffic in the main and south channels.

OYSTER GROUND RATING

Low risk.


PACIFIC OCEAN
BAYOCEAN PENINSULA
BAY CITY
Sewage Treatment Plant
Marina
Overnight Campground
Boundary of Potential Oyster Area
Closed to Commercial Shellfish
Harvest by State Board of Health
Major Clam Bed
Oyster Leases
TIDELAND MAP
OF
TILLAMOOK BAY
STATE OF OREGON
DIVISION OF STATE LANDS
APRIL 1972

APPENDIX C

Kelch, William J., 1977. Drug Resistance, Source, and Environmental Factors that Influence Fecal Coliform Levels of Tillamook Bay. Thesis Oregon State University, Corvallis, Oregon.

SUMMARY

Fecal coliform bacteria were isolated from Tillamook Bay, Oregon and its tributaries during the rainy season and attempts were made to establish the origin of the bay fecal coliforms by comparing the antibiotic resistance patterns of the isolated bacteria. The major findings of this study are:

1. Except the Kilchis River site, which was above the drainage basin, the fecal coliform levels of the tributaries exceeded those of the bay.
2. The count fluctuated by month, being the highest after heavy rainfall.
3. The 176 antibiotic resistance patterns exhibited by 1,917 isolates did not show site specific characteristics.
4. The antibiotic resistance was readily transferable to *E. coli* K-12 (strain W3110) with frequencies of 72.7% for streptomycin (Sm), 20.7% for ampicillin (Am), and 9.1% for tetracycline (Tc).
5. The bay fecal coliform counts were highly correlated with the counts of the tributaries, antibiotic resistance, recreational use of the rivers, and precipitation.
6. The ambient temperature showed a negative correlation with the bay count.
7. Two linear regression models that predicted the bay fecal coliform count were developed by the use of a computerized stepwise multiple linear regression program.

TABLE 5. Fecal coliform counts (colony forming units per 100 ml).

MONTH	KILCHIS RIVER	TRASK RIVER	TILLAMOOK RIVER	WILSON RIVER	MEAN OF FOUR RIVERS	TILLAMOOK BAY[a]	PASTURE I	PASTURE II	PASTURE III
OCTOBER	13.9	8.8	66.0	20.0	27.2	3.6			
NOVEMBER	3.0	67.0	34.0	63.0	42.0	42.0			
DECEMBER	1.0	42.0	34.0	17.0	23.5	27.0			
JANUARY	2.7	0.0	13.5	8.5	6.2	4.7			
FEBRUARY	7.0	132.0	112.0	105.0	89.0		TNTC[b]	670.0	540.0
MARCH	0.5	0.0	32.0	11.0	10.9	7.3			740.0

[a] Average of four separate counts.

[b] Too numerous to count.

TABLE 6. Correlation matrix of river and bay fecal coliform counts.

	KILCHIS RIVER	TRASK RIVER	TILLAMOOK RIVER	WILSON RIVER	TILLAMOOK BAY
KILCHIS RIVER		-0.2004	0.8350	0.0166	-0.3679
TRASK RIVER	-0.2004		0.0256	0.8619	0.9825
TILLAMOOK RIVER	0.8350	0.0256		0.1283	-0.1220
WILSON RIVER	0.0166	0.8619	0.1283		0.8420
TILLAMOOK BAY	-0.3679	0.9825	-0.1220	0.8420	

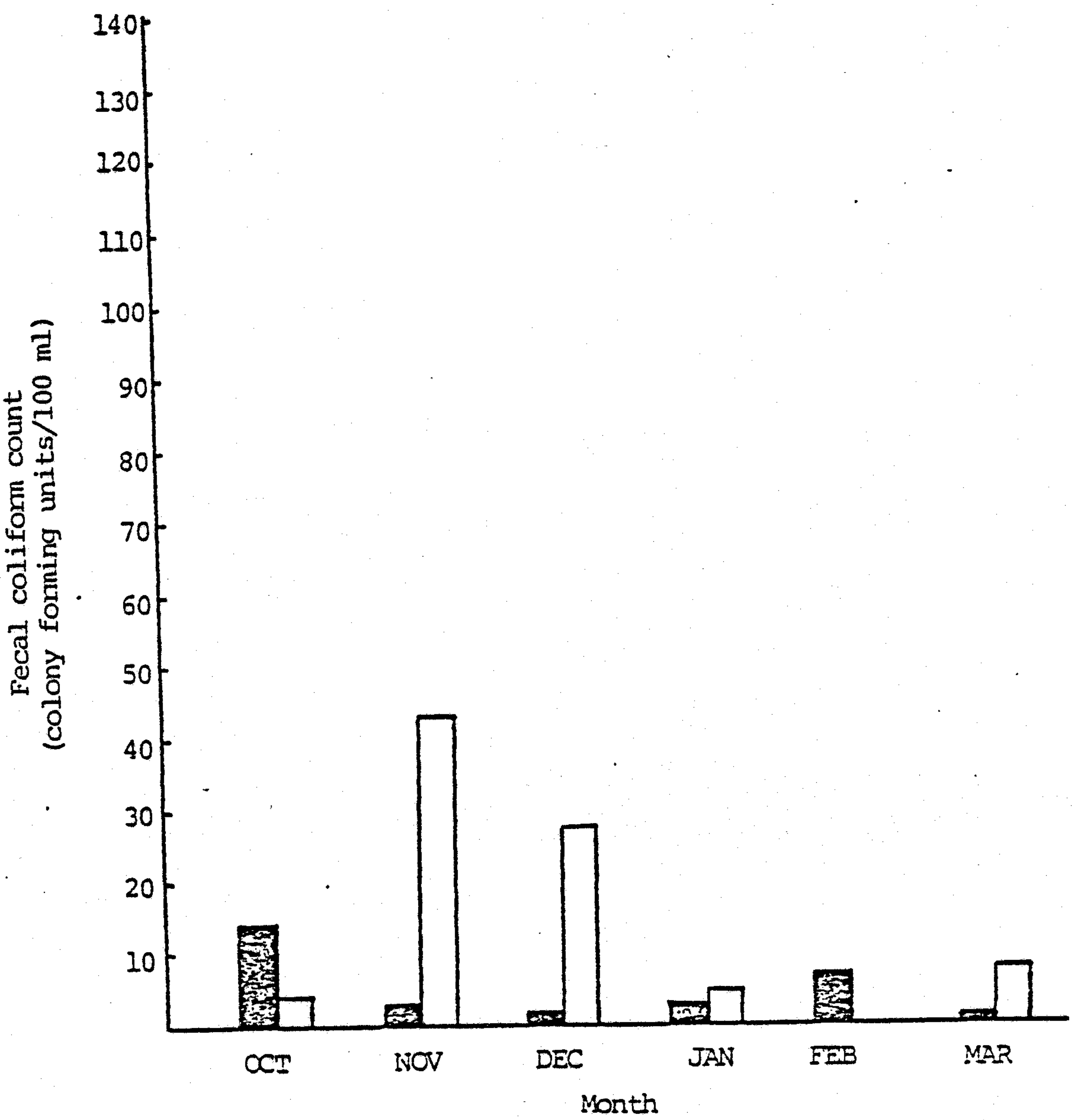


Figure 4. Fecal coliform counts in Kilchis River (darkened) and Tillamook Bay.

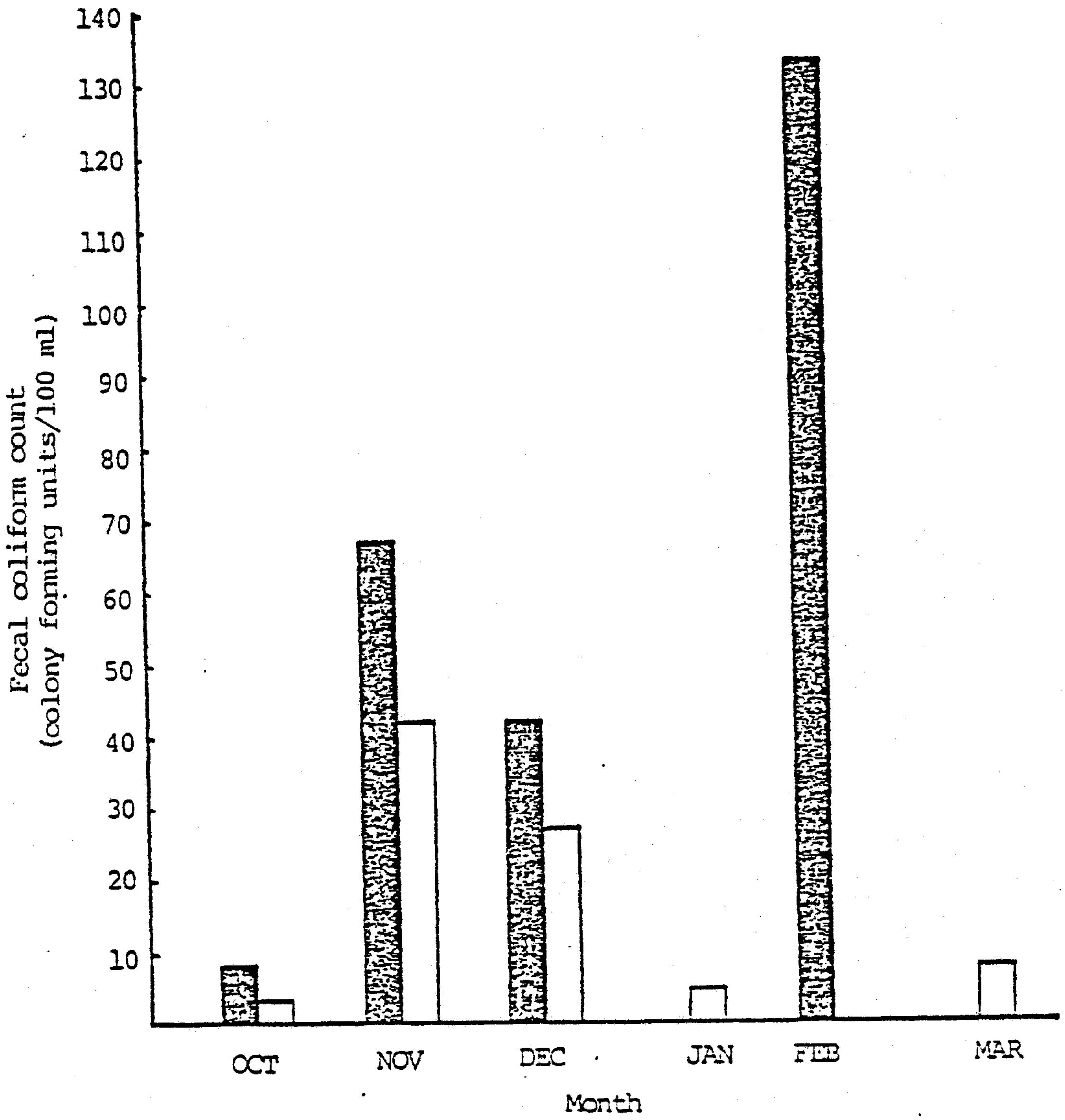


Figure 5. Fecal coliform counts in Trask River (darkened) and Tillamook Bay.

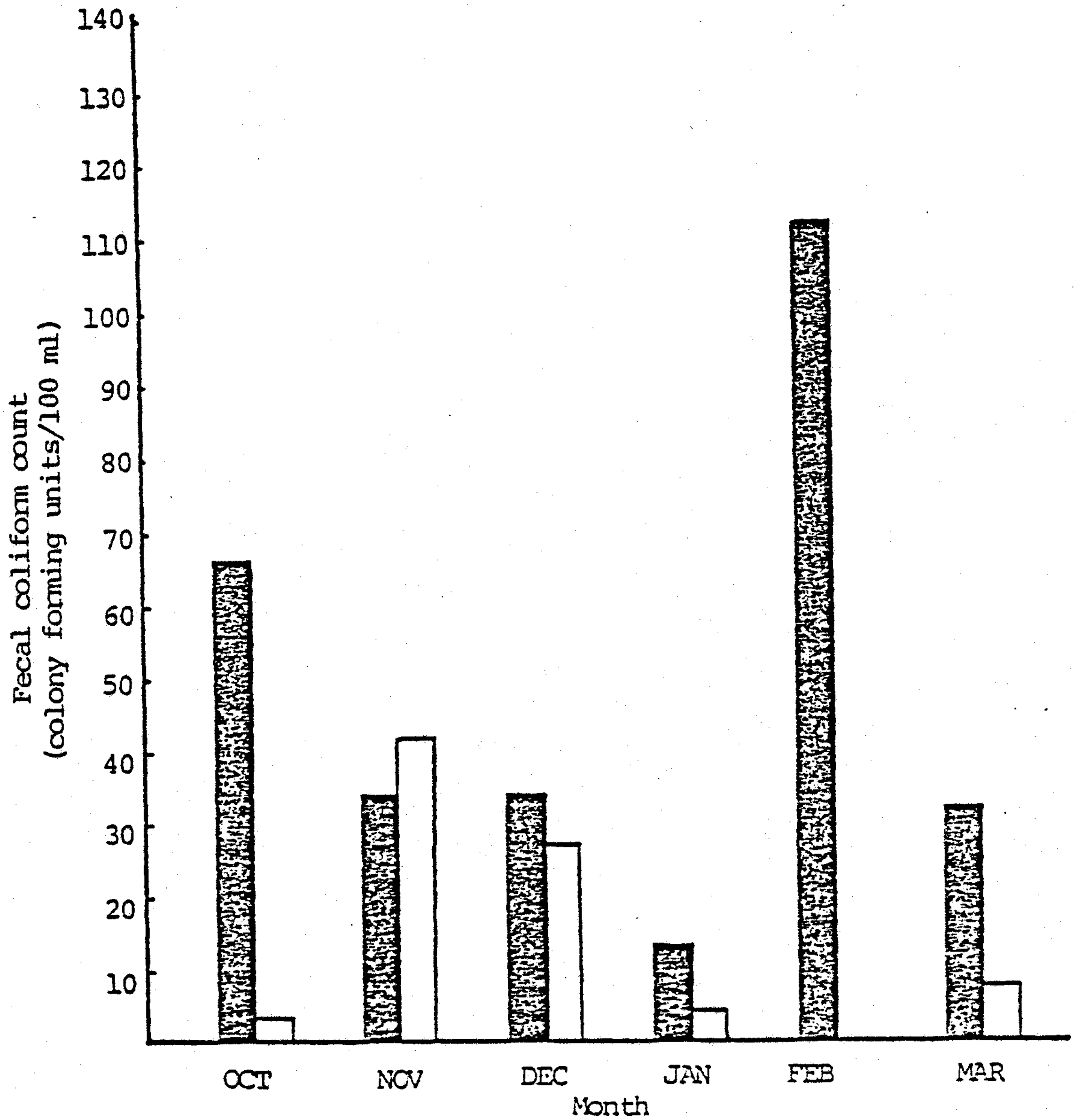


Figure 6. Fecal coliform counts in Tillamook River (darkened) and Tillamook Bay.

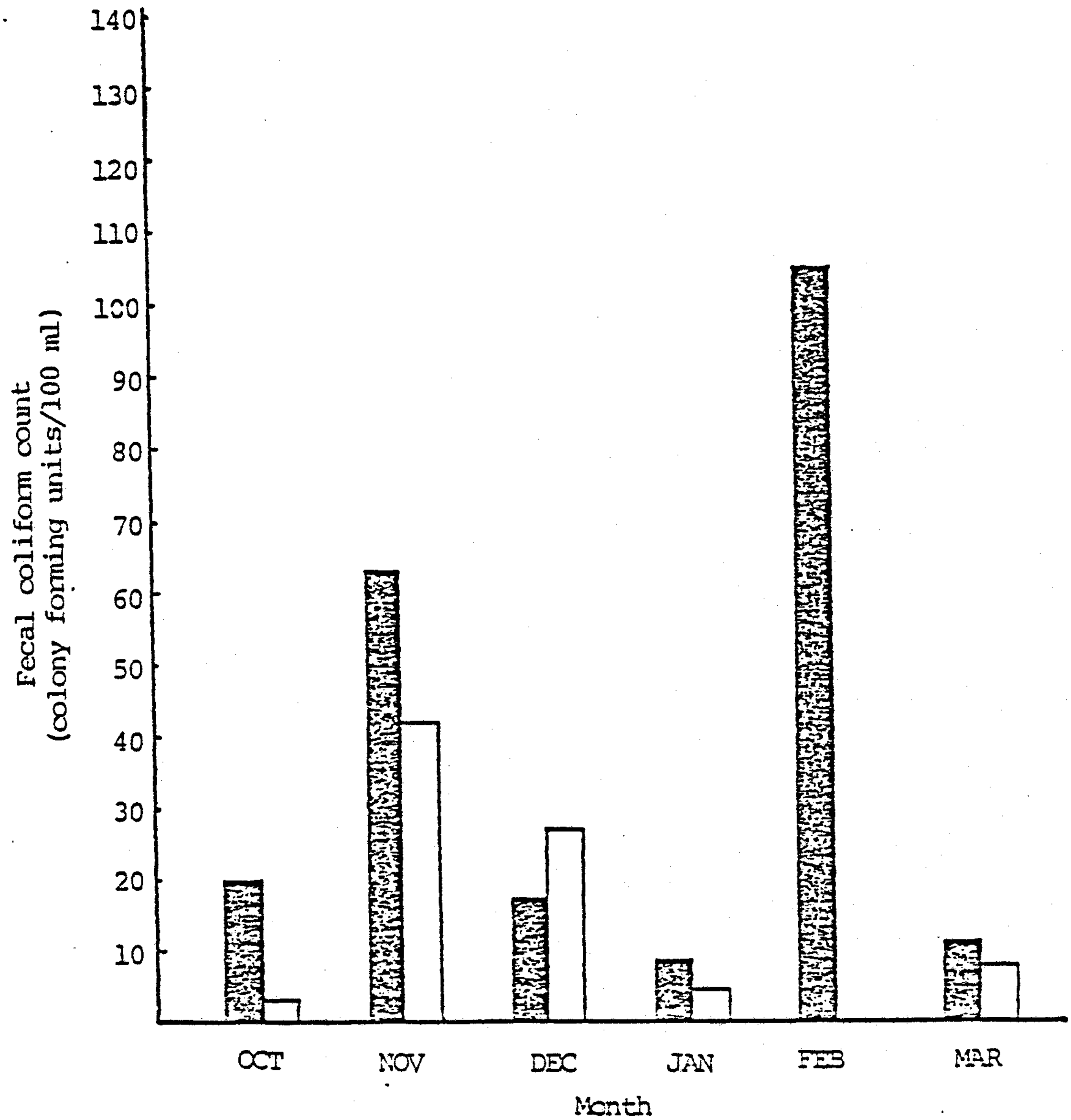


Figure 7. Fecal coliform counts in Wilson River (darkened) and Tillamook Bay.

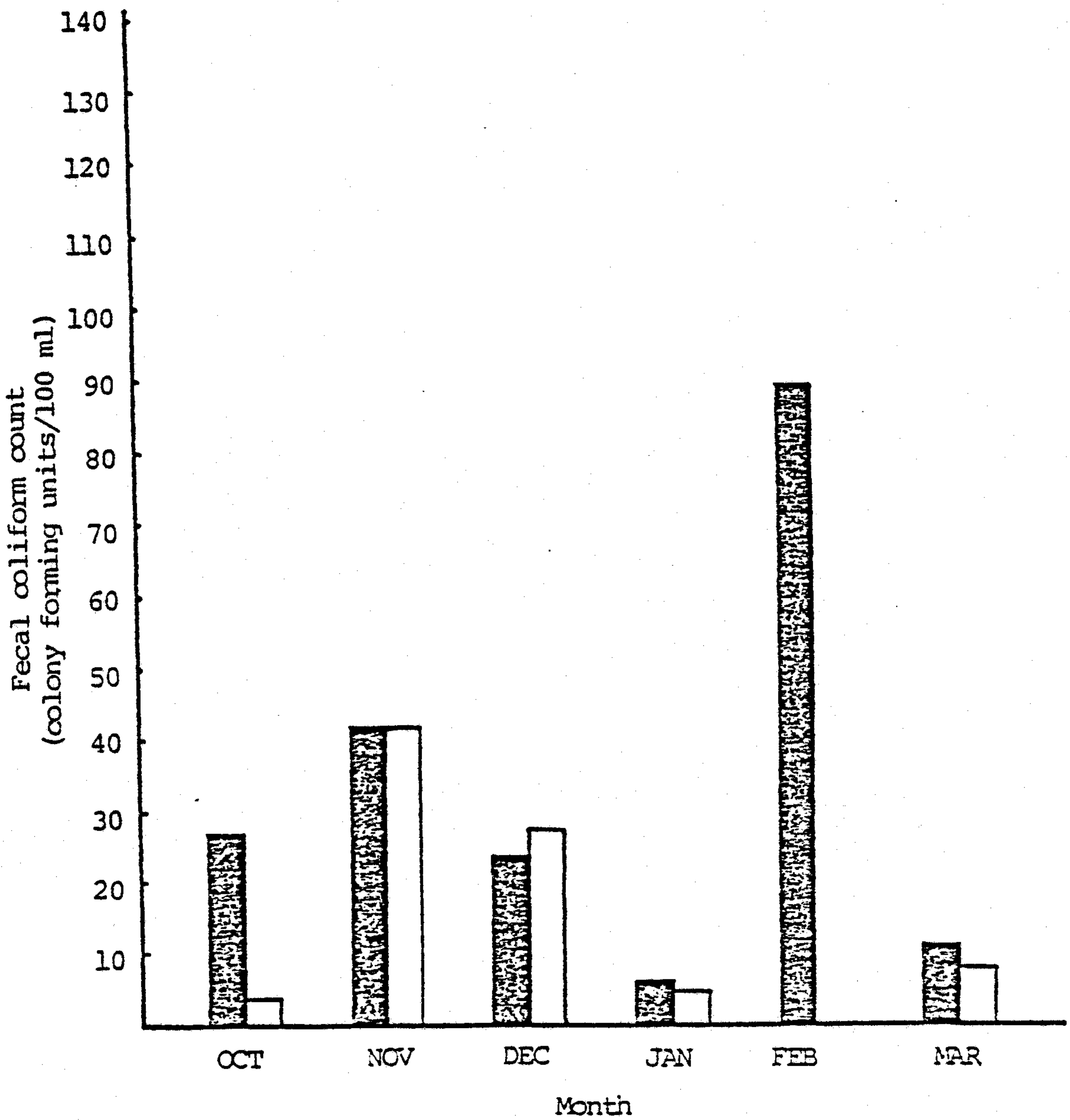


Figure 8. Fecal coliform counts, mean of four rivers (darkened) and Tillamook Bay.

APPENDIX D

Kelch, W.J. and J.S. Lee, 1978. Modeling Techniques for Estimating Fecal Coliforms in Estuaries. Jour. Water Poll. Fed., May 1978: 862-868.

Variable symbols	Variable[a]
$X_1 - X_4$	Kil, Tra, Til, Wil R FC/100 ml
$X_5 - X_8$	Kil, Tra, Til, Wil R AHB/0.01 ml
$X_9 - X_{11}$	Log Kil, Til, Wil R FC/100 ml
$X_{12} - X_{15}$	Log Kil, Tra, Til, Wil R AHB/0.01 ml
X_{16}	Mean lo temp (°F) - 6 pre da
X_{17}	Mean hi temp (°F) - 6 pre da
X_{18}	Lo temp (°F) - pre da
X_{19}	Hi temp (°F) - pre da
X_{20}	Lo temp (°F) - samp da
X_{21}	Hi temp (°F) - samp da
X_{22}	Avr min temp (°F) - pre mo
X_{23}	Avr max temp (°F) - pre mo
X_{24}	Avr temp (°F) - pre mo
X_{25}	Log mean lo temp (°F) - 6 pre da
X_{26}	Log mean hi temp (°F) - 6 pre da
X_{27}	Log lo temp (°F) - pre da
X_{28}	Log hi temp (°F) - pre da
X_{29}	Log lo temp (°F) - samp da
X_{30}	Log hi temp (°F) - samp da
X_{31}	Log avr min temp (°F) - pre mo
X_{32}	Log avr max temp (°F) - pre mo
X_{33}	Log avr temp (°F) - pre mo
X_{34}	Precip (in) - pre mo
X_{35}	Precip (in) - pre da
X_{36}	Avr precip (in) - 6 pre da
X_{37}	Log precip (in) - pre mo
X_{38}	Log avr precip (in) - 6 pre da
$X_{39} - X_{48}$	% FC, Kil R, res Sm[b], Sp, Tc, Ct, Ot, Nm, Ni, Su, Km, Pc
$X_{49} - X_{60}$	% FC, Tra R, res Cm, Sm, Ap, Tc, Ct, Ot, Nm, Ni, Na, Su, Km, Pc
$X_{61} - X_{72}$	% FC, Til R, res Cm, Sm, Ap, Tc, Ct, Ot, Nm, Ni, Na, Su, Km, Pc
$X_{73} - X_{83}$	% FC, Wil R, res Cm, Sm, Ap, Tc, Ct, Ot, Nm, Ni, Su, Km, Pc
$X_{84} - X_{95}$	% FC, AS, res Cm, Sm, Ap, Tc, Ct, Ot, Nm, Ni, Na, Su, Km, Pc
$X_{96} - X_{100}$	Sal from Kil, Tra, Til, Wil, all R
$X_{101} - X_{105}$	Stl from Kil, Tra, Til, Wil, all R
$X_{106} - X_{110}$	Flow in Kil, Tra, Til, Wil, all R (cfs)
$X_{111} - X_{118}$	% FC[c] res > 7, 6, 5, 4, 3, 2, 1, 0 anti
$X_{119} - X_{126}$	% FC[c] res 7, 6, 5, 4, 3, 2, 1, 0 anti
X_{127}	Diff bet samp time and time of next pre hi tide (min)
X_{128}	Ht of next pre hi tide (ft)
X_{129}	Ht of next pre lo tide (ft)
$X_{130} - X_{132}$	Ht of next pre hi tide - mo DTL, MTL, or MSL (ft)
$X_{133} - X_{135}$	Mo DTL, MTL, or MSL - ht of next pre lo tide (ft)

[a] Abbreviations are: AHB = aerobic heterotrophic bacteria; anti = antibiotic(s); AS = all sources; avr = average; bet = between; cfs = cubic feet/second; da = day; DTL = diurnal tide level; FC = fecal coliforms; ft = feet; hi = high; ht = height; in = inch; Kil = Kilchis; lo = low; max = maximum; min = minimum; mo = month; MSL = mean sea level; MTL = mean tide level; pre = previous; precip = precipitation; R = river; res = resistant; sal = salmon; samp = sampling; stl = steel head; Til = Tillamook; Tra = Trask; Wil = Wilson.

[b] Antibiotic abbreviations are: Cm = chloramphenicol, Sm = streptomycin, Ap = ampicillin, Tc = tetracycline, Ct = chlortetracycline, Ot = oxytetracycline, Nm = neomycin, Ni = nitrofurazone, Su = sulfathiazole, Km = kanamycin, and Pc = procaine penicillin G.

[c] Excluding bay and pasture FC.

FIGURE 2. List of independent variables.

Independent variable (X)	Regression coefficient	Standard error of regression coefficient	F value	P value	Significance level	Coefficient of multiple determination	Intercept
X_2, Tra R FC/100 ml	0.55C78	0.06116	83.48	<.005	0.005	0.965	3.7551
X_4, Wil R FC/100 ml	0.63919	0.23648	7.31	<.100	0.10	0.709	1.6434
X_{11}, log Wil R FC/100 ml	41.786	16.39631	6.49	<.100	0.10	0.684	-35.743
X_{18}, lo temp (°F)-pre da	-1.6254	0.44691	13.23	<.050	0.05	0.815	76.733
X_{19}, hi temp (°F)-pre da	-1.9699	0.43304	20.69	<.025	0.025	0.873	129.60
X_{27}, log lo temp (°F)-pre da	-139.31	30.70039	20.5	<.025	0.025	0.873	233.43
X_{28}, log hi temp (°F)-pre da	-259.92	50.60271	26.38	<.025	0.025	0.898	472.79
X_{36}, avr precip (in)-6 pre da	71.423	23.71304	9.07	<.100	0.10	0.751	-6.6495
X_{39}, % FC res Sm-Kil R	0.30098	0.06820	19.47	<.025	0.025	0.866	4.9730
X_{40}, % FC res Ap-Kil R	0.59218	0.23252	6.49	<.100	0.10	0.684	10.650
X_{44}, % FC res Nm-Kil R	0.88835	0.34881	6.49	<.100	0.10	0.684	10.650
X_{46}, % FC res Su-Kil R	1.7762	0.69742	6.49	<.100	0.10	0.684	10.650
X_{47}, % FC res Km-Kil R	5.3316	2.09343	6.49	<.100	0.10	0.684	10.650
X_{48}, % FC res Pc-Kil R	0.91674	0.14310	41.04	<.010	0.01	0.932	3.1910
X_{67}, % FC res Nm-Til R	2.0455	0.84865	5.81	<.100	0.10	0.659	0.61713
X_{71}, % FC res Km-Til R	2.9516	1.05612	7.81	<.100	0.10	0.722	3.6557
X_{90}, % FC res Nm-AS	1.0236	0.39267	6.80	<.100	0.10	0.694	3.6644
X_{94}, % FC res Km-AS	7.4112	1.64054	20.41	<.025	0.025	0.872	-8.3227
X_{96}, Sal from Kil R	0.10875	0.03816	8.12	<.100	0.10	0.730	7.0894
X_{117}, % FC res > 1 anti	1.0243	0.15786	42.10	<.010	0.10	0.933	-37.144
X_{122}, % FC res 4 anti	7.7258	2.83970	7.40	<.100	0.10	0.712	-5.9328
X_{124}, % FC res 2 anti	1.1685	0.40850	8.18	<.100	0.10	0.732	-12.696
X_{129}, ht of next pre lo tide (ft)	13.027	4.83290	7.26	<.100	0.10	0.708	0.89676
X_{133}, mo DTL-ht of next pre lo tide (ft)	-13.279	5.37363	6.11	<.100	0.10	0.670	51.551
X_{134}, mo MTL-ht of next pre lo tide (ft)	-14.404	5.59548	6.63	<.100	0.10	0.688	58.058
X_{135}, mo MSL-ht of next pre lo tide (ft)	-14.410	5.45957	6.97	<.100	0.10	0.699	58.624
Dependent variable = log bay FC/100 ml (Y_2)							
X_2, Tra R FC/100 ml	-0.014774	0.0033168	19.84	<.025	0.025	0.869	0.68119
X_{16}, mean lo temp (°F) -6 pre da	-0.10044	0.042086	5.70	<.100	0.10	0.655	4.9463
X_{18}, lo temp (°F) - pre da	-0.046823	0.010412	20.22	<.025	0.025	0.871	2.7524
X_{19}, hi temp (°F) - pre da	-0.057990	0.0054406	113.61	<.005	0.005	0.974	4.3463
X_{25}, log mean lo temp (°F) -6 pre da	-9.3659	3.79277	6.10	<.100	0.10	0.670	15.916
X_{27}, log lo temp (°F) - pre da	-3.9545	0.73822	28.70	<.025	0.025	0.905	7.1750
X_{28}, log hi temp (°F) - pre da	-7.5884	0.53656	200.0	<.001	0.001	0.985	14.339
X_{36}, avr precip (in) -6 pre da	1.8571	0.77979	5.67	<.100	0.10	0.654	0.41640
X_{39}, % FC res Sm-Kil R	0.0085512	0.0016420	27.12	<.025	0.025	0.900	0.68983
X_{48}, % FC res Pc-Kil R	0.023839	0.0066395	12.89	<.050	0.05	0.811	0.67224
X_{85}, % FC res Sm-AS	0.010605	0.0041304	6.59	<.100	0.10	0.687	0.55555
X_{90}, % FC res Nm-AS	0.030694	0.0097770	12.23	<.050	0.05	0.803	0.63177
X_{94}, % FC res Km-AS	0.20128	0.053001	14.42	<.050	0.05	0.828	0.34370
X_{117}, % FC res > 1 anti	0.027403	0.0063830	18.43	<.025	0.025	0.860	-0.41707
X_{124}, % FC res 2 anti	0.035409	0.0090764	19.22	<.025	0.025	0.875	0.13179

[a]See Table 2 for explanation of abbreviations.

FIGURE 3. Results of preliminary statistical analysis; significant F-values only; dependent variable = bay FC/100 ml (Y_1). (See Figure 2 for explanation of abbreviations.)

APPENDIX E

Westgarth, W.C., 1967. Tillamook Bay Study. Office Memorandum, Oregon State Board of Health, Portland, Oregon.

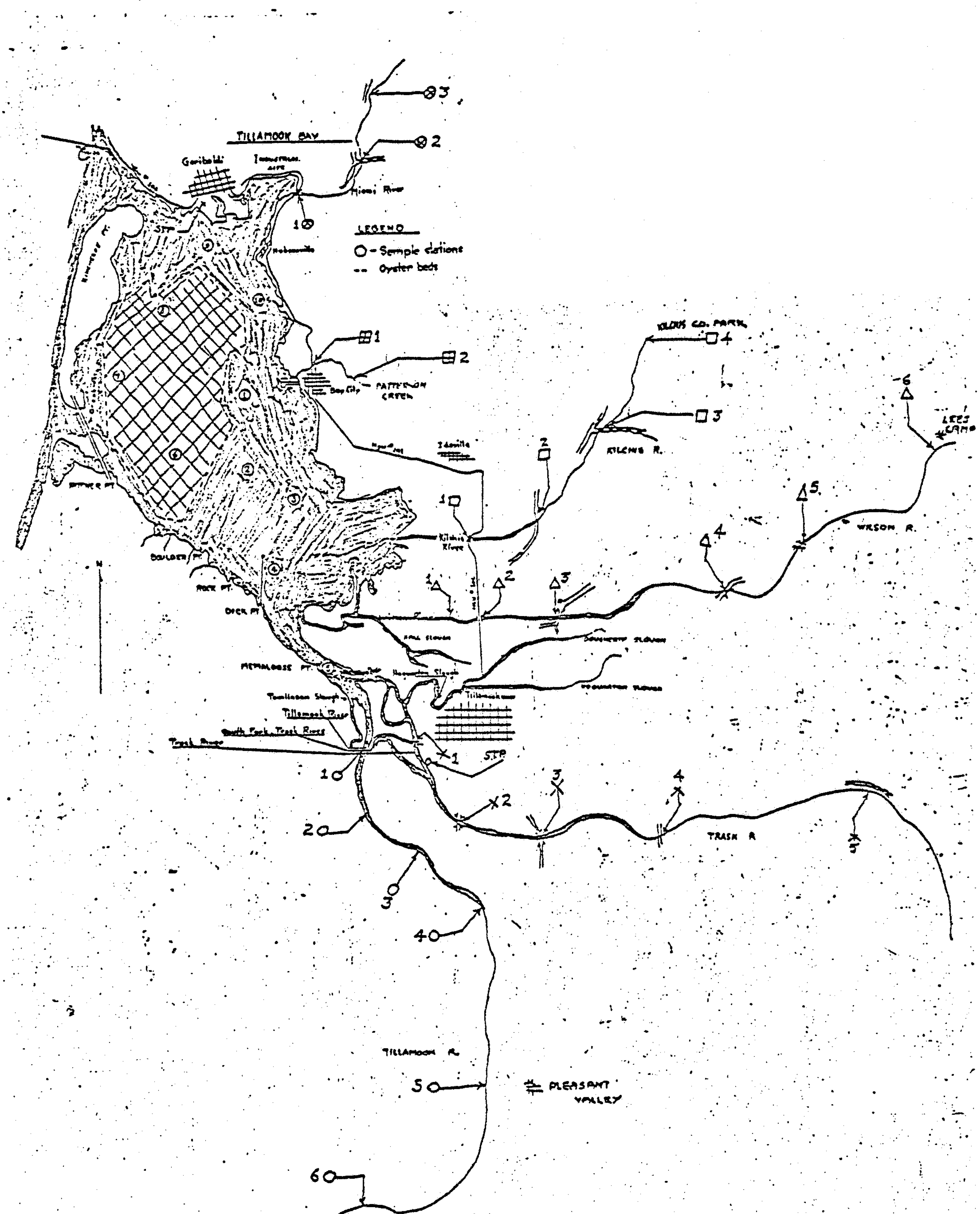
ESTABLISHED WATER SAMPLE STATIONS

SHELLFISH SANITATION PROGRAM

TILLAMOOK BAY, TILLAMOOK COUNTY

1967

Station	Description & Distances From Point	Latitude & Longitude
1	Temp. Channel Marker 45 yds N, 15 yds E EW "A" △	45° 31' 19" N, 123° 53' 57" W
2	Temp. Channel Marker 50 yds N, 15 yds E EW "D" △	45° 30' 31" N, 123° 54' 13" W
3	Pile - Near Covered Jetty 70 yds S, 10 yds E	45° 30' 06" N, 123° 54' 05" W
4	Dick Pt. Dike Near North End 145 yds S, 100 yds E	45° 29' 26" N, 123° 54' 02" W
5	Memaloose Pt. 100 yds N, 0 yds E/W	45° 28' 15" N, 123° 53' 12" W
6	Boulder Pt. 200 yds N, 80 yds W	45° 29' 56" N, 123° 55' 08" W
7	Opposite Sandstone Pt. 225 yds S, 1.59 miles W	45° 31' 46" N, 123° 55' 54" W
8	Flashing Green Light #"17" .91 mi. S, 100 yds W	45° 32' 27" N, 123° 55' 10" W
9	Flashing Light #"19" 30 yds S, 100 yds W	45° 33' 14" N, 123° 54' 50" W
10	Hobsonville Pt. 700 yds S, 340 yds E	45° 32' 30" N, 123° 54' 05" W
11	Sandstone Pt. 100 yds N, .62 mi. W	45° 31' 54" N, 123° 54' 36" W


TILLAMOOK BAY
Garibaldi
Miami River
LEGEND
O - Sample stations
-- Oyster beds
KILCHIS CO. PARK
Bay City
PATTERSON CREEK
Idaville
KILCHIS R.
WILSON R.
LEES CAMP
BOULDER PT.
ROCK PT.
DICK PT.
MEMALOOSE PT.
Hoquarton Slough
Tillamook
Tomlinson Slough
Tillamook River
South Fork, Trask River
Trask River
STP
TRASK R
TILLAMOOK R.
PLEASANT VALLEY

Mean MPN Counts from Westgarth 1967

		Rain 12/19/66	Clear 1/9/67	Part Rain 1/17/67
Miami R.	1	2400	490	460
	2	233	97	277
	3	18	229	252
Kilchis R.	1	340	127	40
	2	270	33	290
	3	233	62	17
	4	93	48	13
Wilson R.	1	330	93	167
	2	483	335	350
	3	230	82	277
	4	75	84	87
	5	30	68	33
	6	285	290	49
Trask R.	1	24150	1900	965
	2	2605	1330	680
	3	1205	1415	1125
	4	233	55	252
	5	190	55	97
Tillamook River	1	3500	930	2375
	2	680	930	2680
	3	1215	430	1665
	4	1950	930	421
	5	2765	150	2400
	6	1305	930	1400
Patterson Creek	1	635	2315*	9
	2	24000	250*	1665
Hall Slough		2183	6700	1100
Dougherty Slough		1115	1215	1100
Hoguarten Slough		1205	1950	588

* Reported here as shown in raw data sheets. Data for this creek suggests possible error in labeling sample.

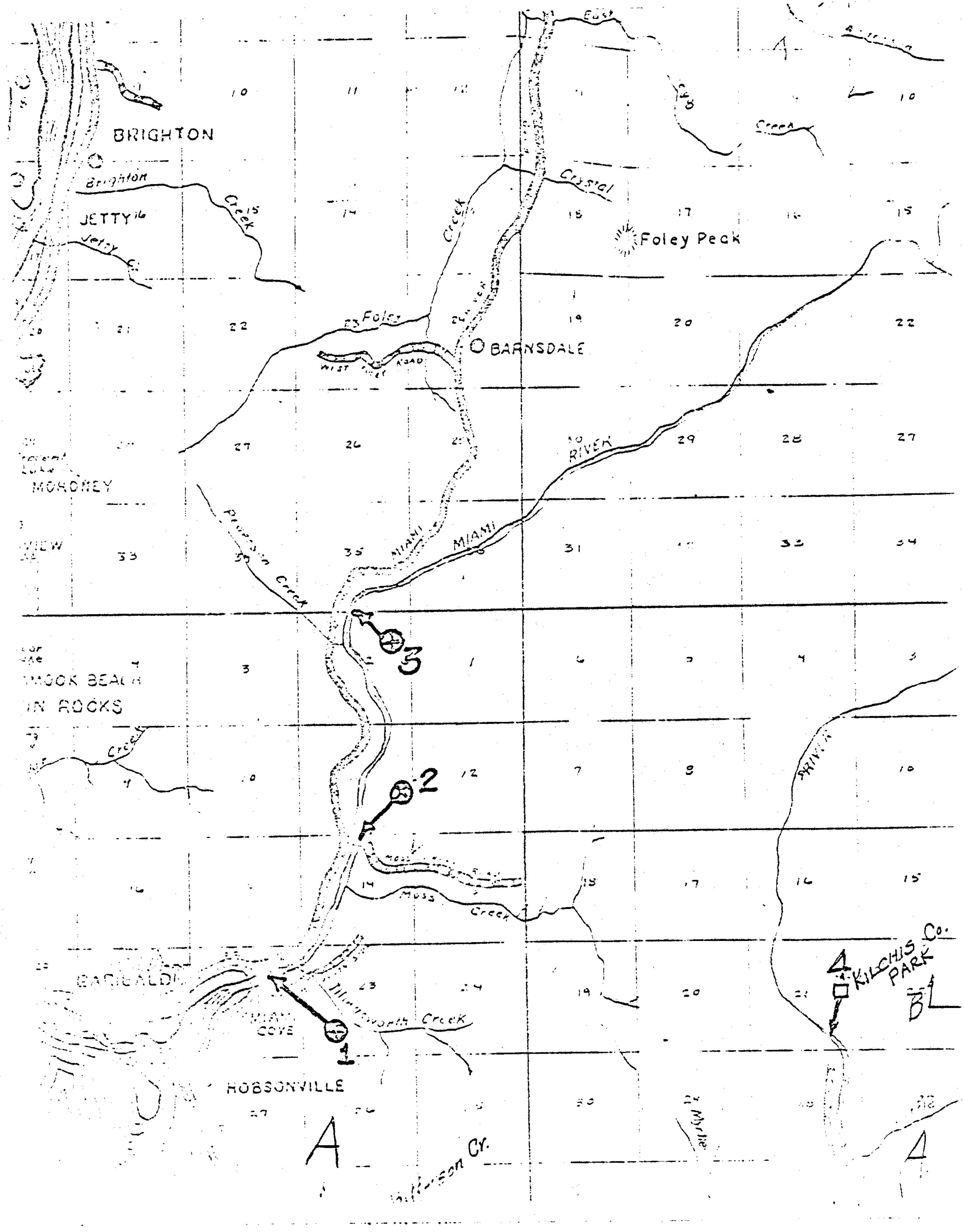
Mean MPN Counts from Westgarth 1967

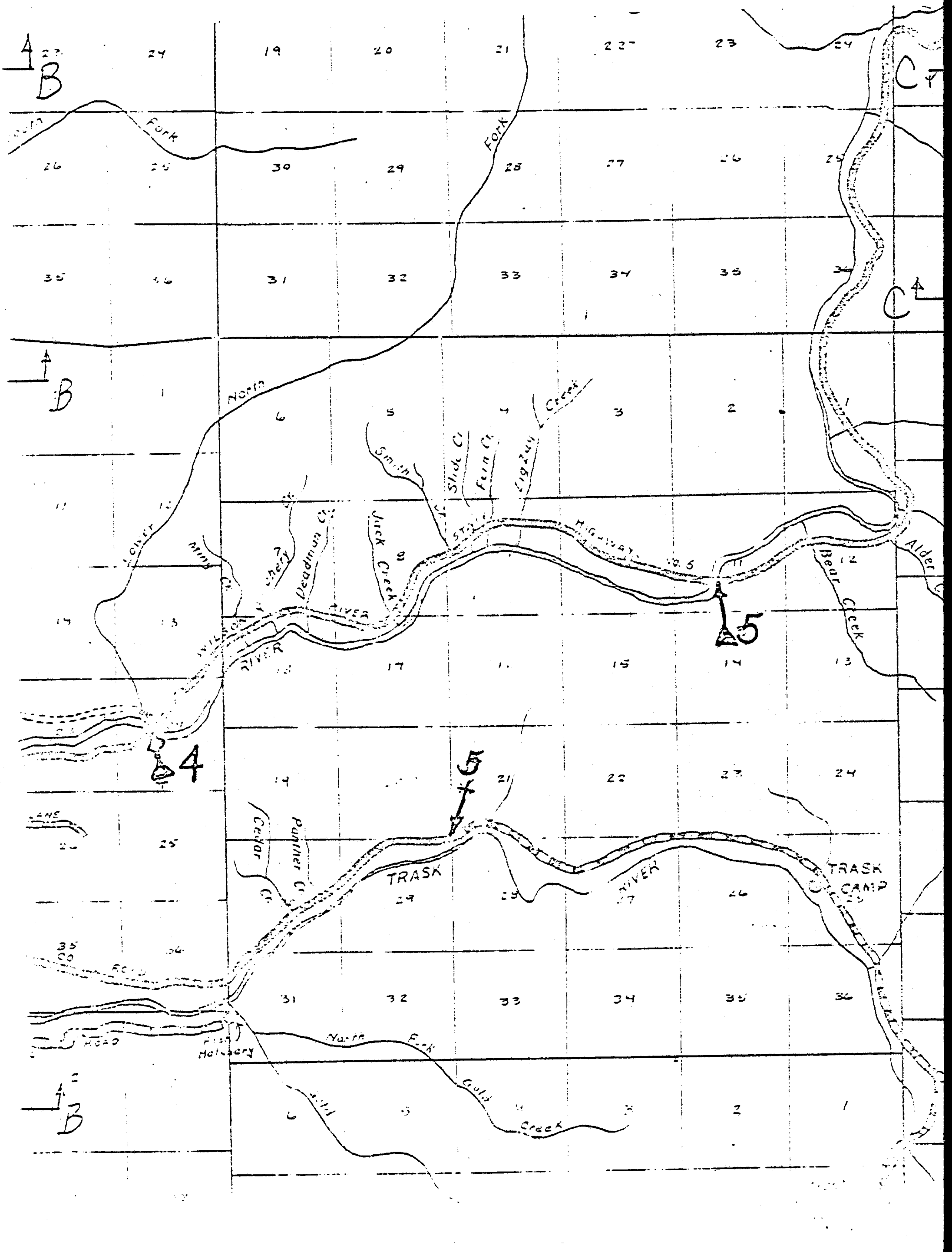
	Rain 12/19/66	Clear 1/9/67	Part Rain 1/17/67
Garibaldi STP	85,000	4,520,000	305,000
Tillamook Cheese	625,000	3,130,000	804,000
Tillamook City STP	94,000	1,510,000	174,000
Tillamook Air Base	780,000	311,000	948,000
Bay #1	430	91	530
2	210	590	260
3	36	161	303
4	430	290	430
5	2,400	430	653
6	240	142	1,100
7	240	560	138
8	290	68	283
9	460	242	357
10	150	54	264

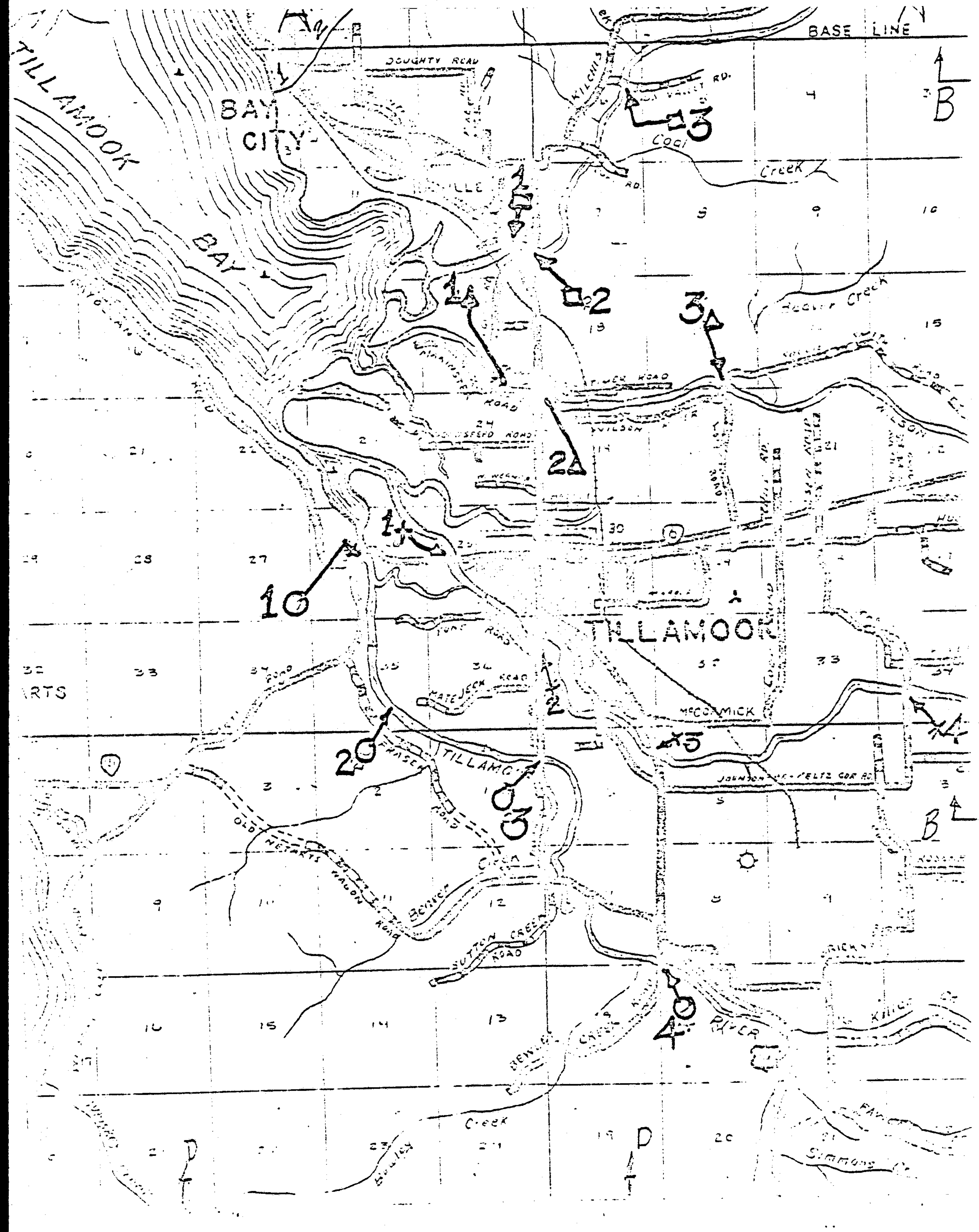
Lowest Station Total % Contribution of Coliforms to Bay*

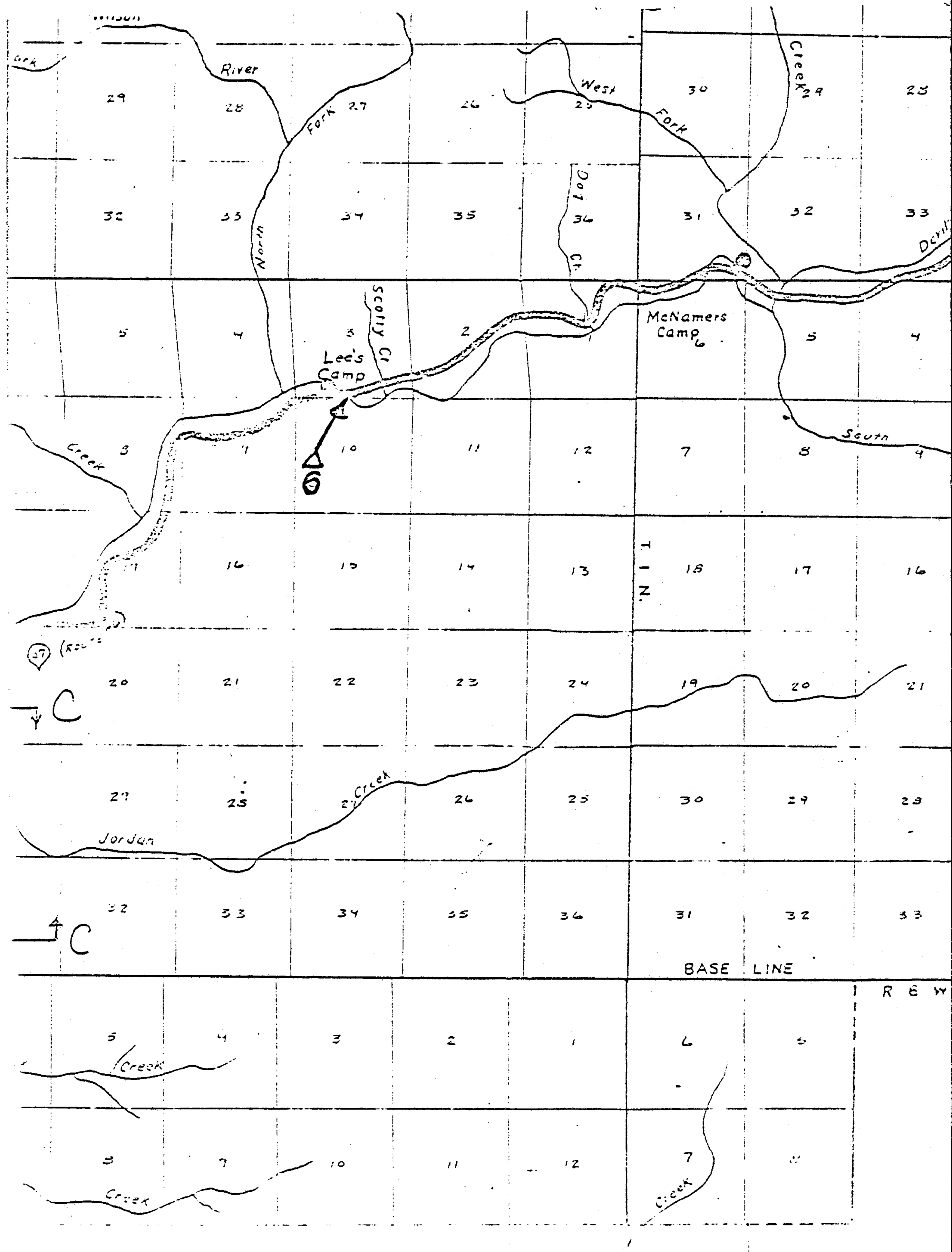
	Rain 12/19/66	Clear 1/9/67	Part Rain 7/17/67
Miami R.	14.4	5.1	4.4
Kilchis R.	1.6	2.5	0.7
Wilson R.	11.9	2.8	10.4
Trask R.	48.8	46.4	51.9
Tillamook R.	6.8	2.9	20.3
Patterson C.	8.2	0.3	1.2
Garibaldi STP	1.0	25.6	2.0
Tillamook Cheese STP	3.5	8.9	3.7
Tillamook City STP	0.4	4.7	0.8
Tillamook Air Base	3.3	0.9	4.4

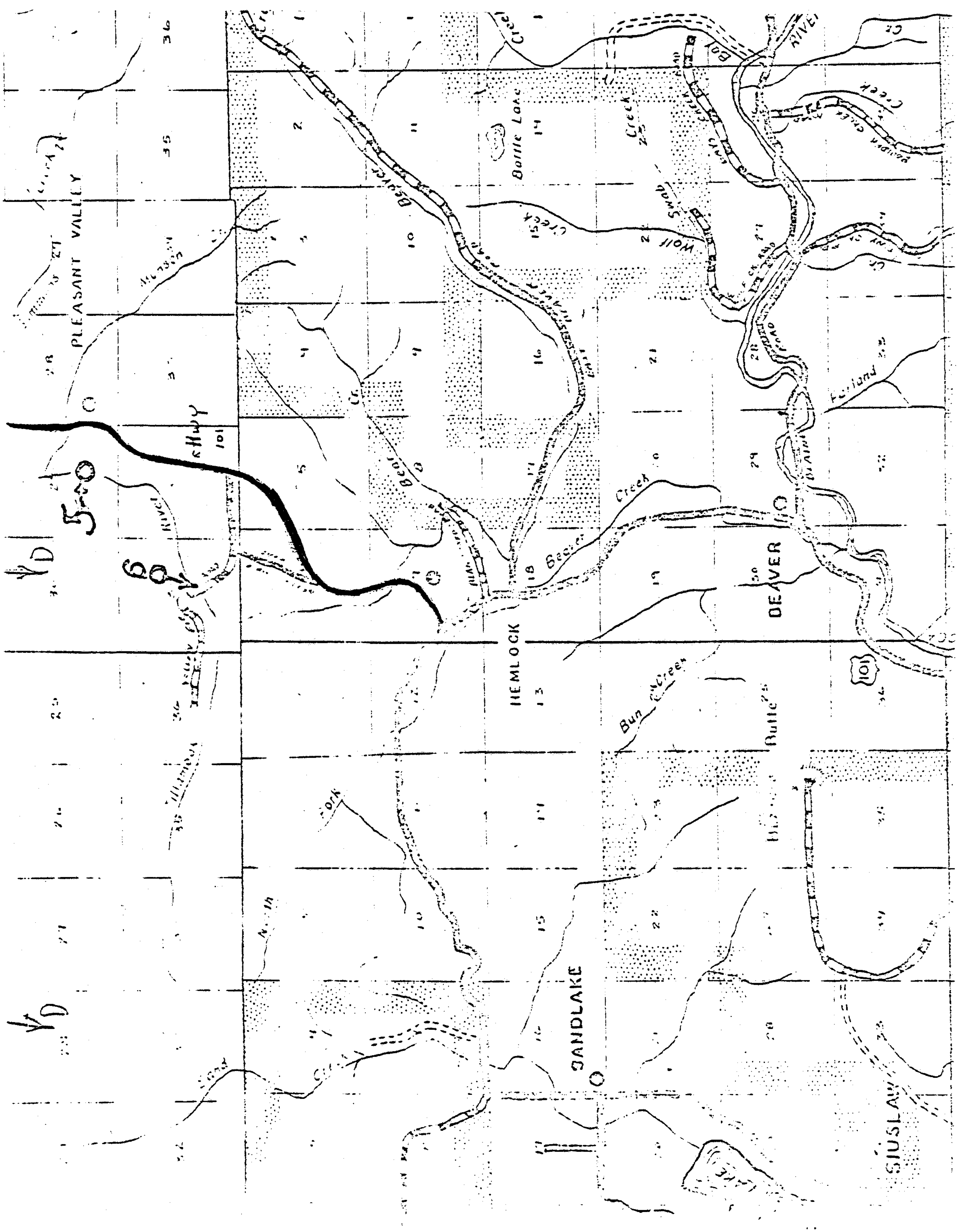
* From Westgarth memo Table 3, 1967


BRIGHTON
Brighton
Creek
JETTY
Jetty
Foley Peak
Crystal
Creek
East
Foley
BARNSDALE
WEST FORK ROAD
RIVER
MORONEY
MIAMI
Creek
3
2
GARIBALDI
MIAMI COVE
1
HOBSONVILLE
Moss
Creek
KILCHIS PARK Co.
RIVER
A
B
Myrtle
Cr.


North Fork
Fork
North
Smith Cr.
Slide Cr.
Fern Cr.
Zig Zag Creek
Jack Creek
Deadman Cr.
Lower
STATE HIGHWAY 6
WILSON RIVER
RIVER
Bear Creek
Alder C
Cedar Cr.
Panther Cr.
TRASK
RIVER
TRASK CAMP
North Fork
Gold
Creek
Fish Hatchery
ROAD
LANE


BASE LINE
TILLAMOOK
BAY
BAY CITY
DOUGHTY ROAD
Coal
Creek
Beaver Creek
TIMBER ROAD
WILSON
TILLAMOOK
McCORMICK
OLD NETARTS WAGON ROAD
FRASER ROAD
SUTTON CREEK ROAD
BEWLEY CREEK ROAD
RIVER
Creek
Simmons Cr.


River
North Fork
West Fork
Creek
Dog Cr.
Scotty Cr
Lee's Camp
McNamers Camp
South
Creek
Jordan
Creek
BASE LINE
T 1 N.
R E W
(Route
C
C
Creek
Creek
Creek


PLEASANT VALLEY
HEMLOCK
BEAVER
SANDLAKE
SIUSLAW
Bottle Lake
Beaver Creek
Bun Creek
Farland
Wolf Creek
101

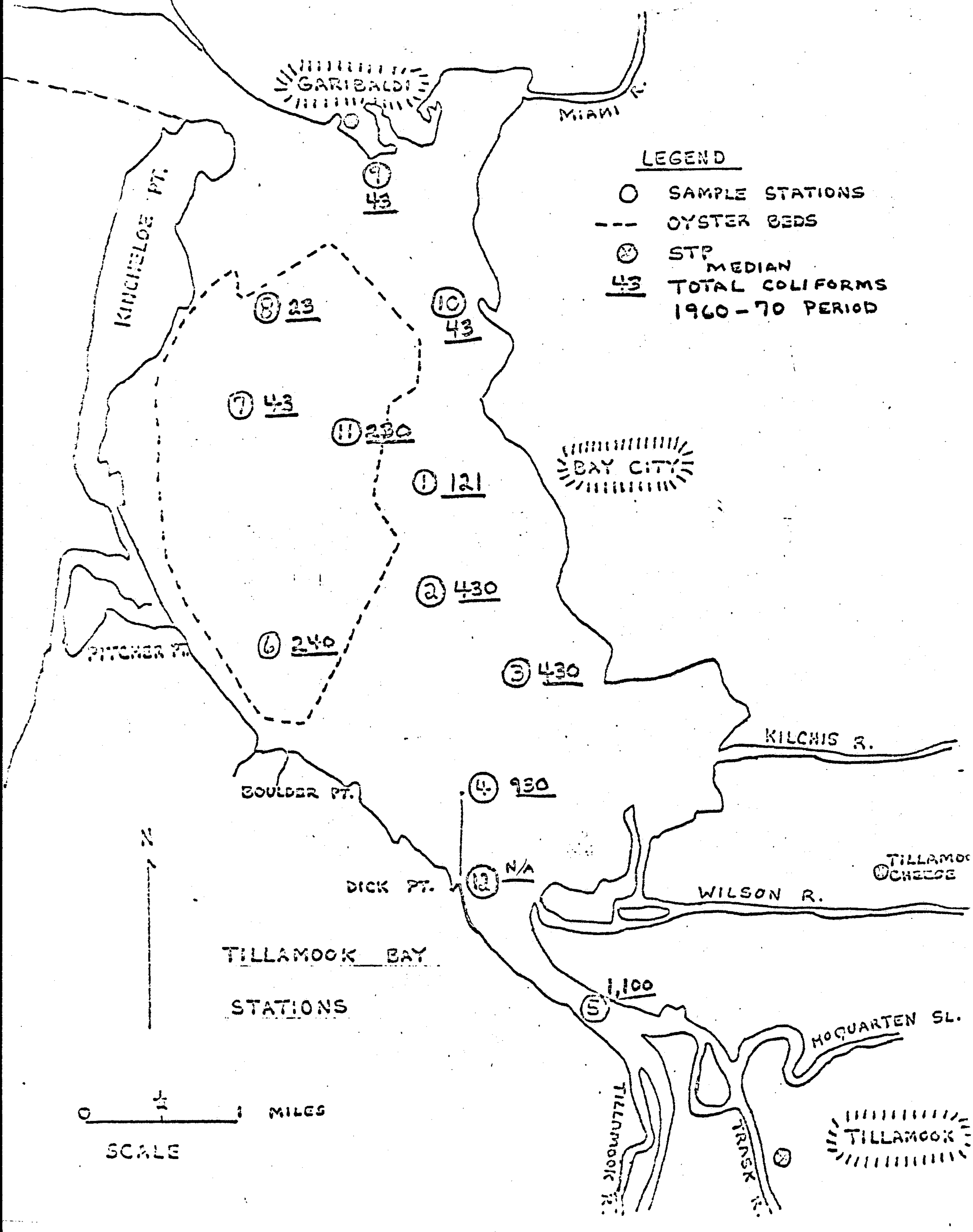
APPENDIX F

Gray, C.H., 1971. Office Memorandum Bacteria Counts for Tillamook Bay. Oregon Dept. of Environmental Quality, Portland, Oregon.

TILLAMOOK BAY

Stations	Median Coliform	*(> 330 MPN/100 ml) Percent Samples in Violation
1	121.5	30
2	430	52
3	430	57
4	930	77
5	1100	82
6	240	40
7	43	19
8	23	12
9	43	20
10	43	16
11	230	41

*Food and Drug Administration states that not more than 10% of the samples shall exceed 330/100 ml.


GARIBALDI
MIAMI R.
KINCHELOE PT.
LEGEND
SAMPLE STATIONS
OYSTER BEDS
STP
MEDIAN
43 TOTAL COLIFORMS
1960-70 PERIOD
9 43
8 23
10 43
7 43
11 230
1 121
BAY CITY
2 430
6 240
PITCHER PT.
3 430
KILCHIS R.
4 930
BOULDER PT.
N
12 N/A
DICK PT.
TILLAMOOK CHEESE
WILSON R.
TILLAMOOK BAY
STATIONS
5 1,100
HOQUARTEN SL.
0 ½ 1 MILES
SCALE
TILLAMOOK R.
TRASK R.
TILLAMOOK

APPENDIX G.

Gray, C.H., 1972. Tillamook Bay Water Bacteriology Study. Oregon Dept. of Environmental Quality. Portland, Oregon.

SUMMARY AND CONCLUSIONS

1. Total coliform counts were below the median 70 MPN standard over the oyster beds at stations 6, 7, 8, and 11.

2. The highest total and fecal coliforms were recorded at stations 3, 4, 5, and 12. These stations pinpoint the inflow and influence of the Kilchis, Wilson, Trask and Tillamook Rivers.

3. Oyster bed samples collected by the Division of Health personnel indicated coliform counts well below FDA's standard of 16,000/100 grams.

4. Sewage treatment samples indicated variable degrees of coliform reductions. City of Garibaldi, which is a primary plant, showed the highest coliform counts > 70,000. Tillamook Cheese, with secondary treatment, also showed high coliform counts. This plant has been plagued by periodic, high strength overloadings. These are in the process of being corrected.

5. The certification standards for the growing and interstate shipping of oysters appears to be being met in Tillamook Bay.

CITY OF GARIBALDI SEWAGE TREATMENT PLANT

Date	Time	MGD Flow	Chlorine Residual	Total Coliform	Fecal Coliform
3/30/72	-	0.65	-	> 70,000	> 70,000
4/2/72	0915	0.50	2.0	< 450	< 450
4/5/72	1200	0.30	2.0	< 450	< 450

TILLAMOOK CHEESE TREATMENT PLANT
(Sewage & Industrial)

Date	Time	MGD Flow	Chlorine Residual	Total Coliform	Fecal Coliform
3/30/72	-	0.10	Too murky	> 70,000	1,300
4/2/72	0830	0.16	4.0	< 45	< 45
4/5/72	1115	0.14	Too turbid	70,000	2,300

CITY OF TILLAMOOK SEWAGE TREATMENT PLANT

Date	Time	MGD Flow	Chlorine Residual	Total Coliform	Fecal Coliform
3/30/72	-	1.7	0.75	> 7,000	2,400
4/2/72	0730	1.2	2.0	< 45	< 45
4/5/72	1100	2.0	2.0	> 7,000	620

PORT OF TILLAMOOK SEWAGE TREATMENT PLANT

Date	Time	Flow MGD	Chlorine Residual	Total Coliform	Fecal Coliform
3/30/72		low	0.75	60	< 45
4/2/72	0700	moderate	0.50	< 45	< 45
4/5/72	1030	-	0.75	< 45	< 45

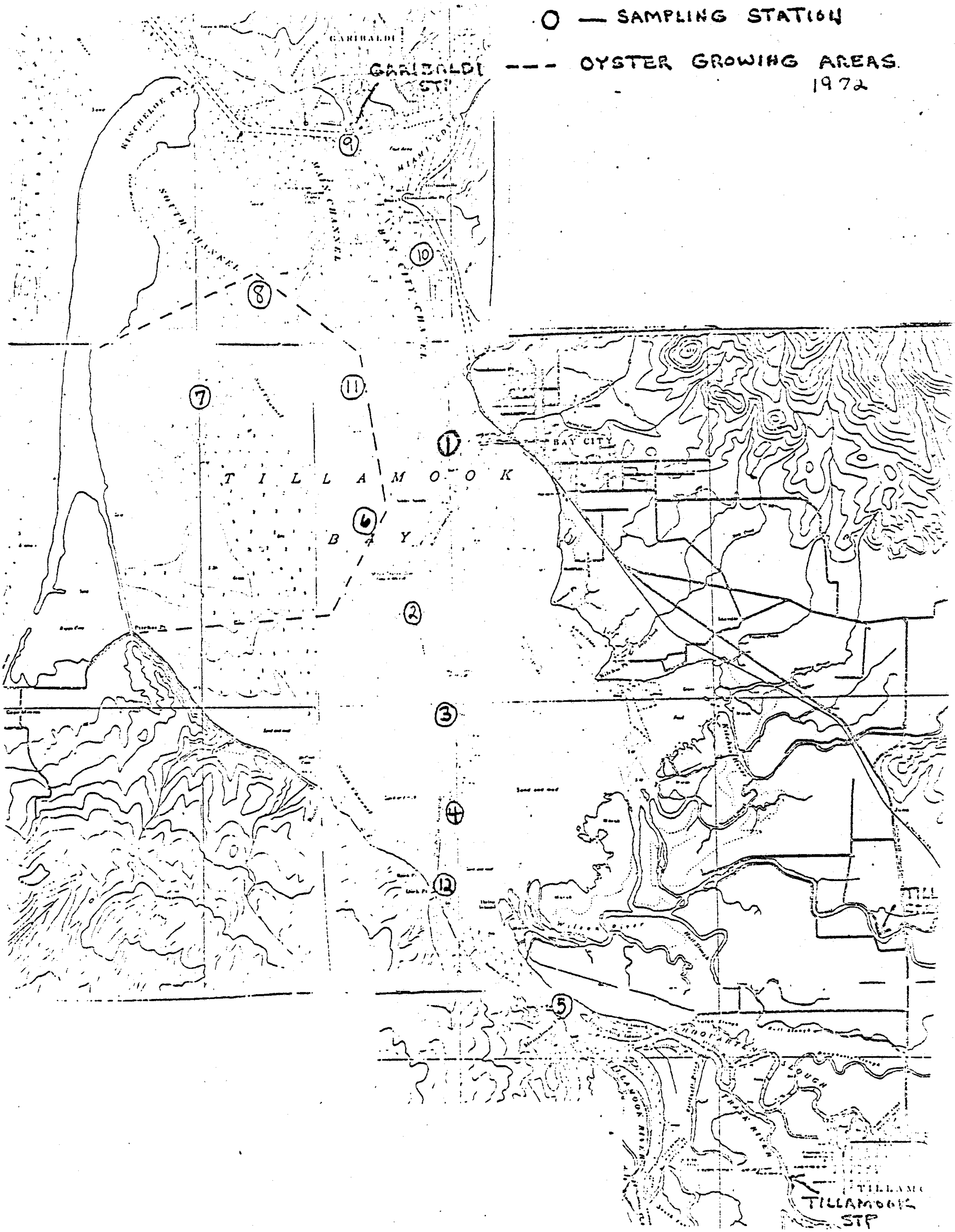
Bacterial Tests on Oysters from Tillamook Bay, Oregon

Date	Total Coliform	Fecal Coliform	Standard Plate Count @ 35°C
3-29-72	45	20	510
	170	45	440
3-31-72	45	20	940
4-1-72	78	< 18	6,900
	130	< 18	2,700
4-2-72	170	< 18	630
	170	20	630
4-3-72	140	< 18	410
	18.0	< 18	640
4-4-72	68.0	40.0	1,100
	120.0	< 18.0	810
4-5-72	210.0	20.0	12,000

TILLAMOOK BAY COLIFORM RESULTS - (13 samples/station)

Station	Median Total Coliform	Median Fecal Coliform	Percentage of Total Coliforms Exceeding 330/100 ml
1	43	6.3	17%
2	93	9.1	15
3	101	23	8
4	210	43	31
5	240	93	46
*6	68	3.6	0
*7	15	< 3.0	0
*8	3.6	< 3.0	0
9	23	3.0	15
10	23	< 3.0	0
*11	23	3.6	0
12	240	23	31

* Oyster growing areas where the median total coliform shall not exceed 70/100 ml, and not more than 10% of the samples ordinarily exceed an MPN of 330/100 ml.


O — SAMPLING STATION
--- OYSTER GROWING AREAS
1972
GARIBALDI
GARIBALDI STP
MIAMI COVE
MAIN CHANNEL
SOUTH CHANNEL
BAY CITY CHANNEL
BAY CITY
T I L L A M O O K
B A Y
1
2
3
4
5
6
7
8
9
10
11
12
TILLAMOOK STP

APPENDIX H.

Gray, C.H., 1973. Comprehensive Sanitary Survey of Tillamook Bay. Dept. of Environmental Quality. Portland, Oregon.

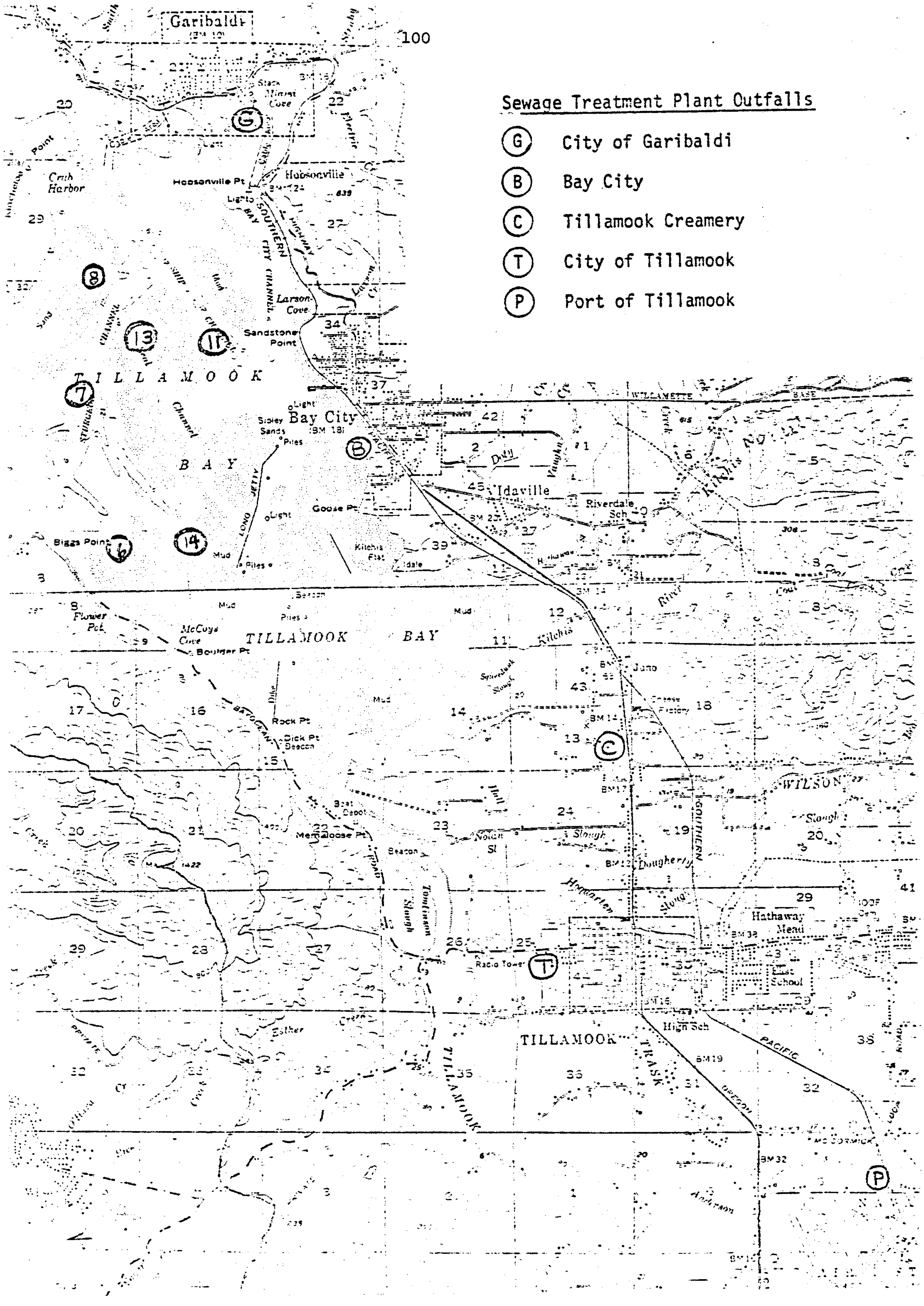
MEDIAN MPN

	Total Coliform	Fecal Coliform
Tillamook Bay Stations		
6	84	3.6
7	18	3.6
8	9.1	< 3.0
11	12.05	3.6
13	23	5.4
14	43	3.6
Sewage Treatment Plants		
Port of Tillamook	≤ 10	< 2
City of Tillamook	770	6
City of Garibaldi	100	6
Tillamook Creamery Association	20	< 2
Bay City	20	< 4
Rivers		
Tillamook R. @ Bewley Cr. Rd. Br.	60	60
Trask R. @ Hwy. 101 Br.	60	60
Wilson R. @ Loop Br. Rd.	230	< 45
Kilchis R. @ Hwy. 101 Br.	60	< 45
Miami R. @ Moss Cr. Rd. Br.	230	60

BAY STATIONS COLIFORM SUMMARY

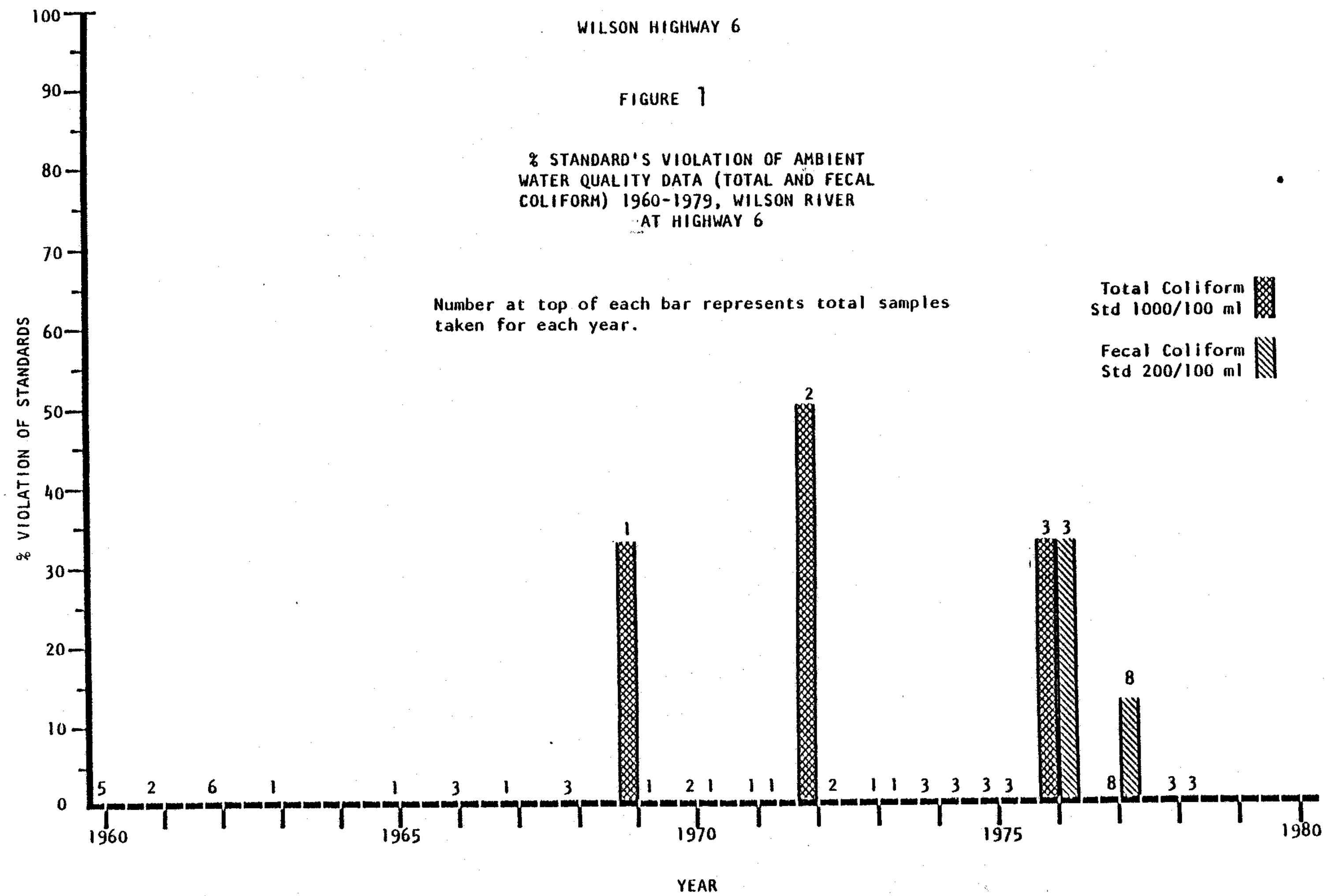
(16 samples/station)

Station	Total Coliforms Min.	Total Coliforms Median	Total Coliforms Max.	Fecal Coliforms Min.	Fecal Coliforms Median	Fecal Coliforms Max.	% of Total Coliforms Exceeding 330/100 ml
6	< 3.0	84	460	< 3.0	3.6	23	13
7	3.6	18	240	< 3.0	3.6	15	0
8	3.6	9.1	240	< 3.0	< 3.0	9.1	0
11	< 3.0	12.05	240	< 3.0	3.6	9.1	0
13	< 3.0	23	93	< 3.0	5.4	23	0
14	9.1	43	93	< 3.0	3.6	23	0


Sewage Treatment Plant Outfalls
G City of Garibaldi
B Bay City
C Tillamook Creamery
T City of Tillamook
P Port of Tillamook
100
Garibaldi
Hobsonville Pt
Hobsonville
Crab Harbor
Larson Cove
Sandstone Point
TILLAMOOK BAY
Bay City
Sibley Sands
Idaville
Riverdale Sch
Goose Pt
Kilchis Flat
Biggs Point
Flower Pt
McCoys Cove
Boulder Pt
TILLAMOOK BAY
Kilchis River
Juno
Cheese Factory
Rock Pt
Dick Pt Beacon
Boat Depot
Memaloose Pt
Hall Slough
Dougherty Slough
Hoquarten Slough
Tomlinson Slough
WILSON
Hathaway Mead
Radio Tower
East School
High Sch
TILLAMOOK
Esther Creek
TRASK
PACIFIC
OREGON
McCORMICK
Anderson

APPENDIX J.

Oregon Department of Environmental Quality, Water Quality Monitoring for Oregon Streams.



WILSON HIGHWAY 6

FIGURE 1

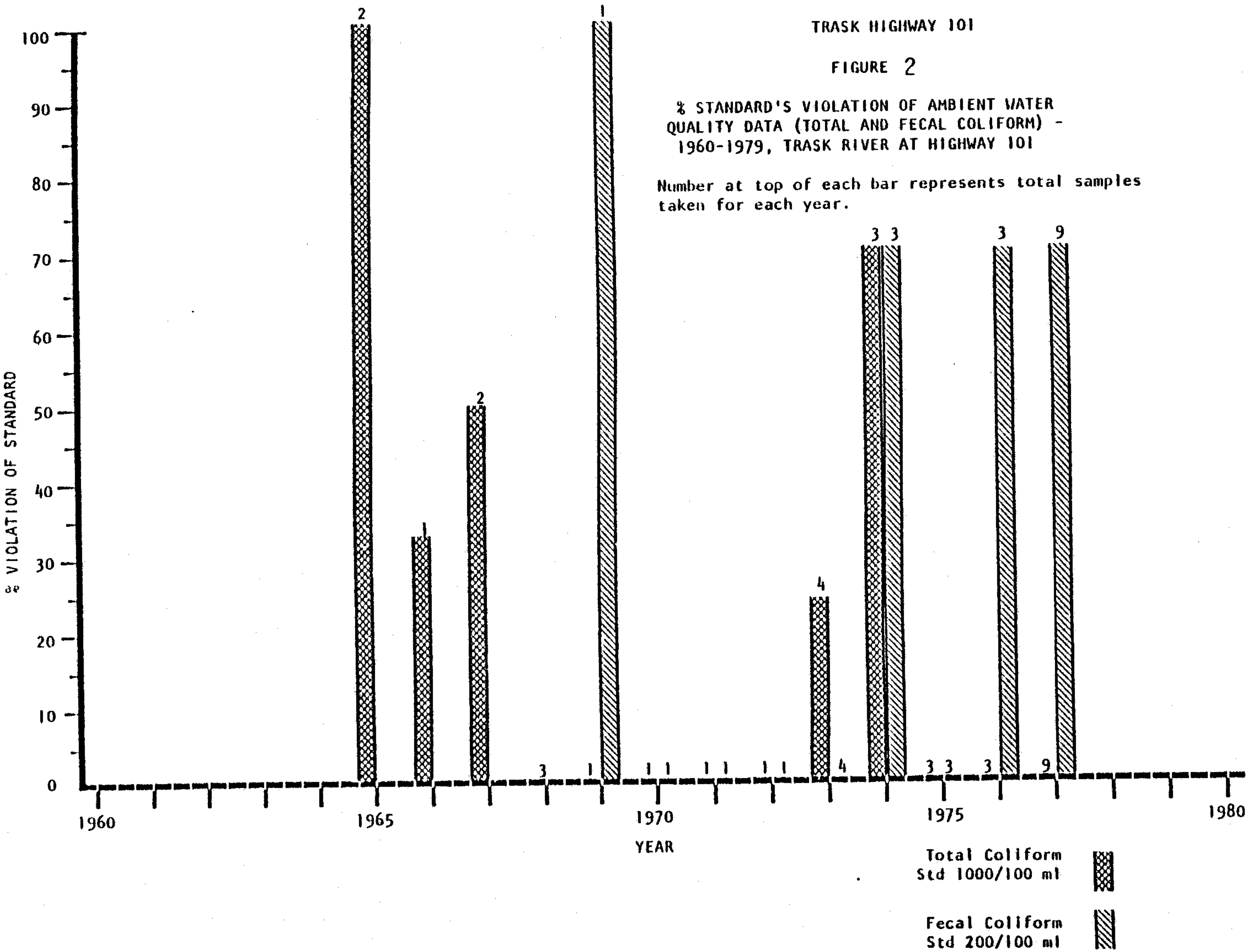
% STANDARD'S VIOLATION OF AMBIENT WATER QUALITY DATA (TOTAL AND FECAL COLIFORM) 1960-1979, WILSON RIVER AT HIGHWAY 6

TRASK HIGHWAY 101

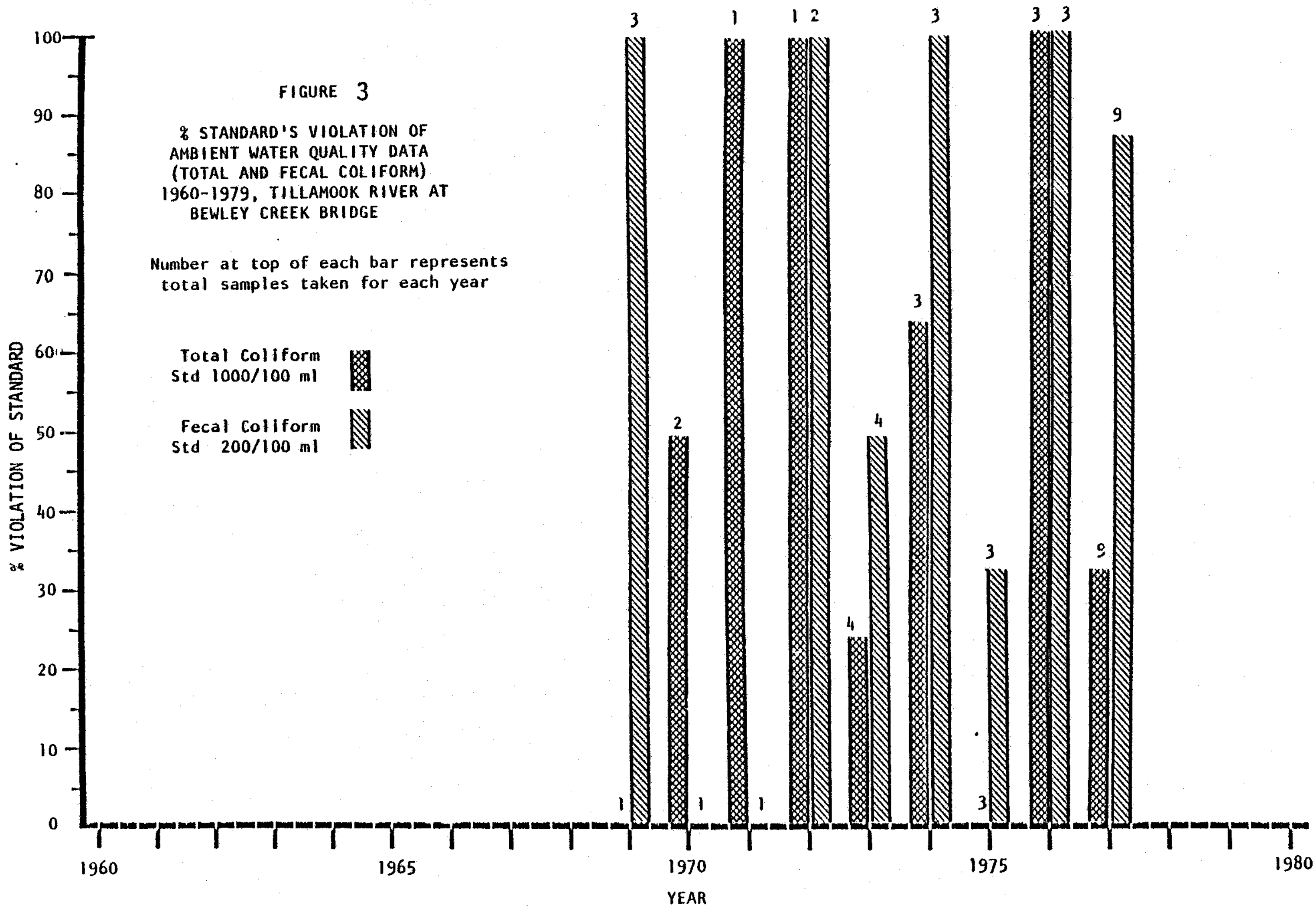
FIGURE 2

% STANDARD'S VIOLATION OF AMBIENT WATER QUALITY DATA (TOTAL AND FECAL COLIFORM) - 1960-1979, TRASK RIVER AT HIGHWAY 101

Number at top of each bar represents total samples taken for each year.



TILLAMOOK BEWLEY CREEK BRIDGE

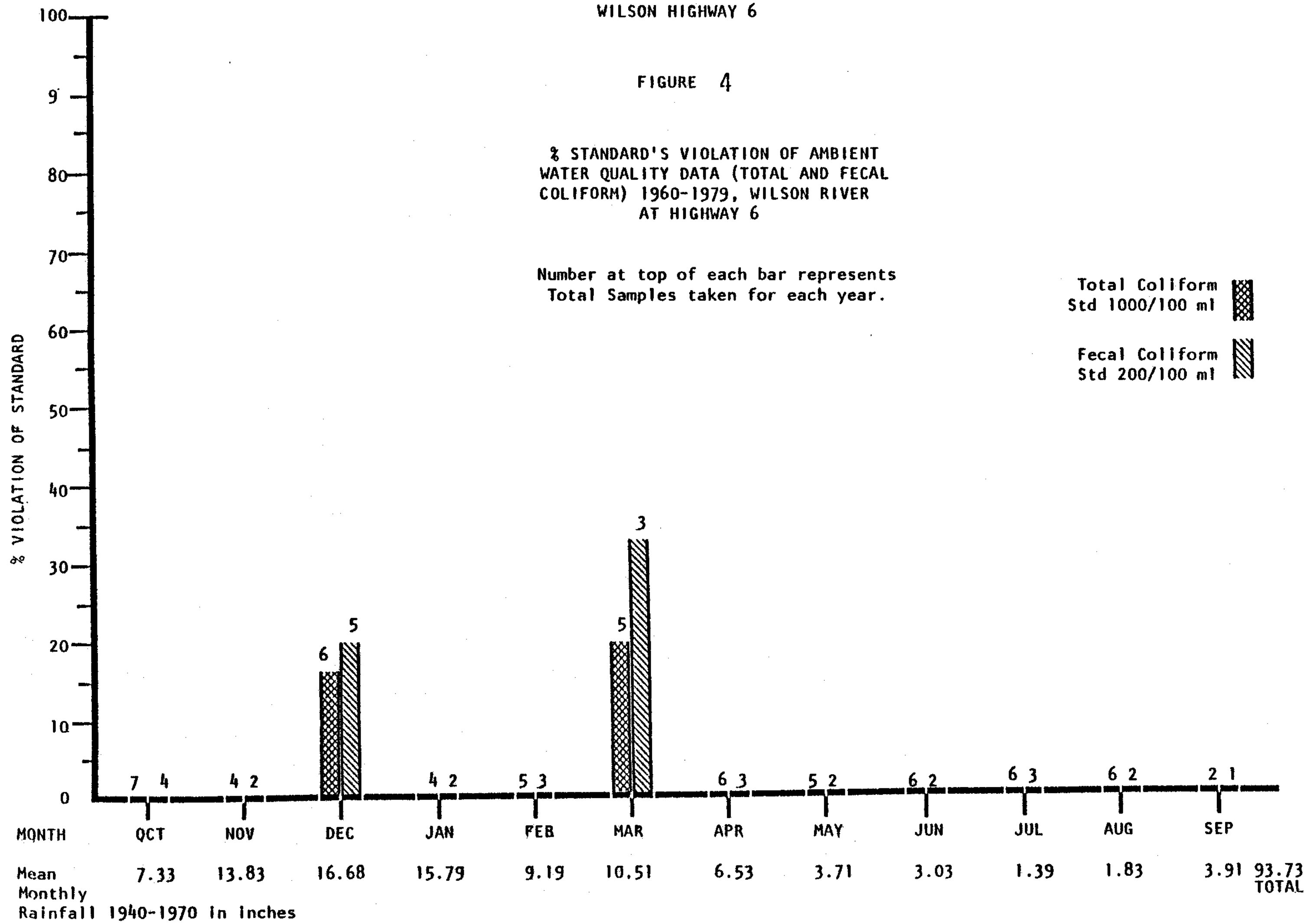


WILSON HIGHWAY 6

FIGURE 4

% STANDARD'S VIOLATION OF AMBIENT WATER QUALITY DATA (TOTAL AND FECAL COLIFORM) 1960-1979, WILSON RIVER AT HIGHWAY 6

Number at top of each bar represents Total Samples taken for each year.

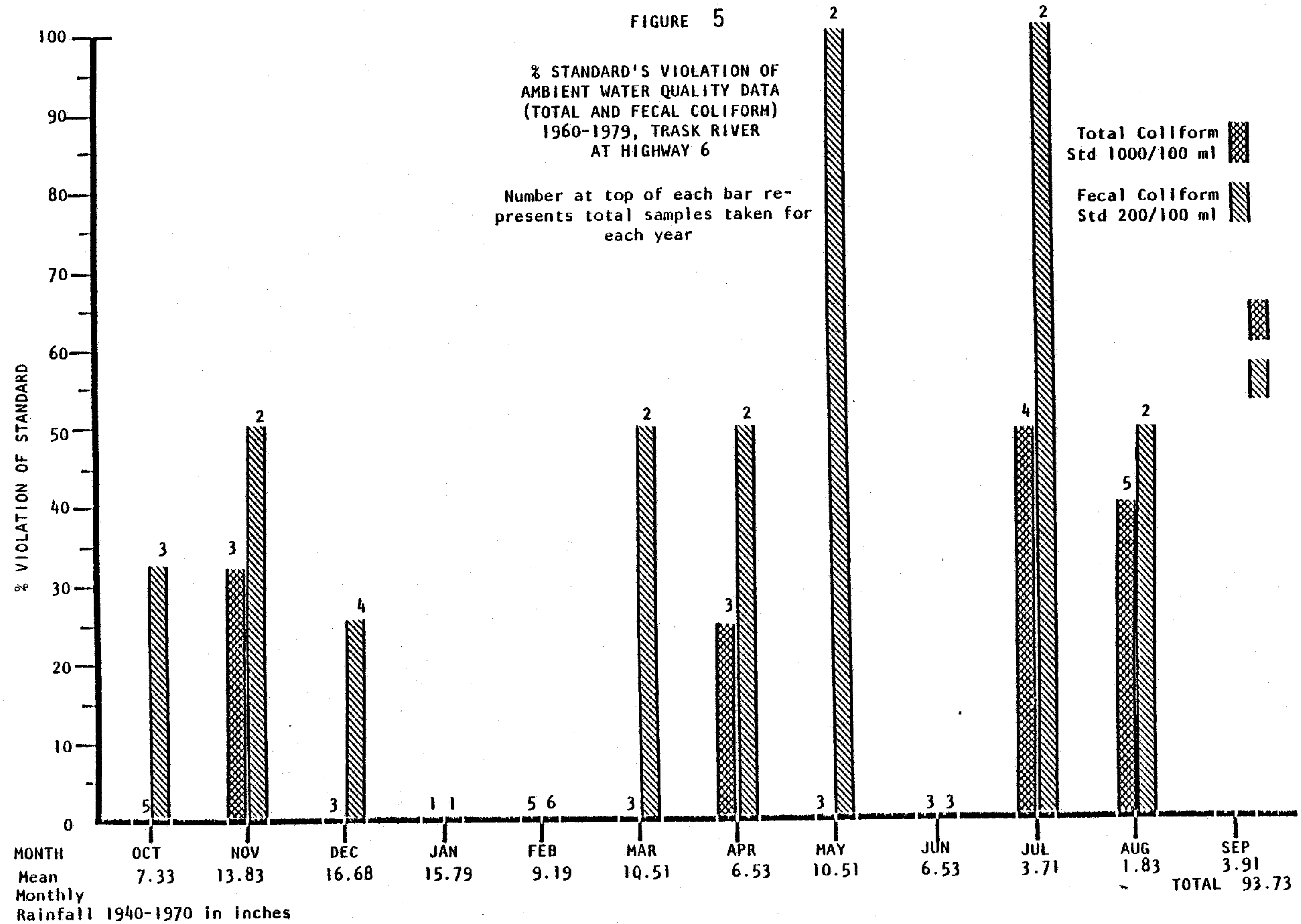


TRASK HIGHWAY 101

FIGURE 5

% STANDARD'S VIOLATION OF
AMBIENT WATER QUALITY DATA
(TOTAL AND FECAL COLIFORM)
1960-1979, TRASK RIVER
AT HIGHWAY 6

Number at top of each bar represents total samples taken for each year



TILLAMOOK BEWLEY CREEK

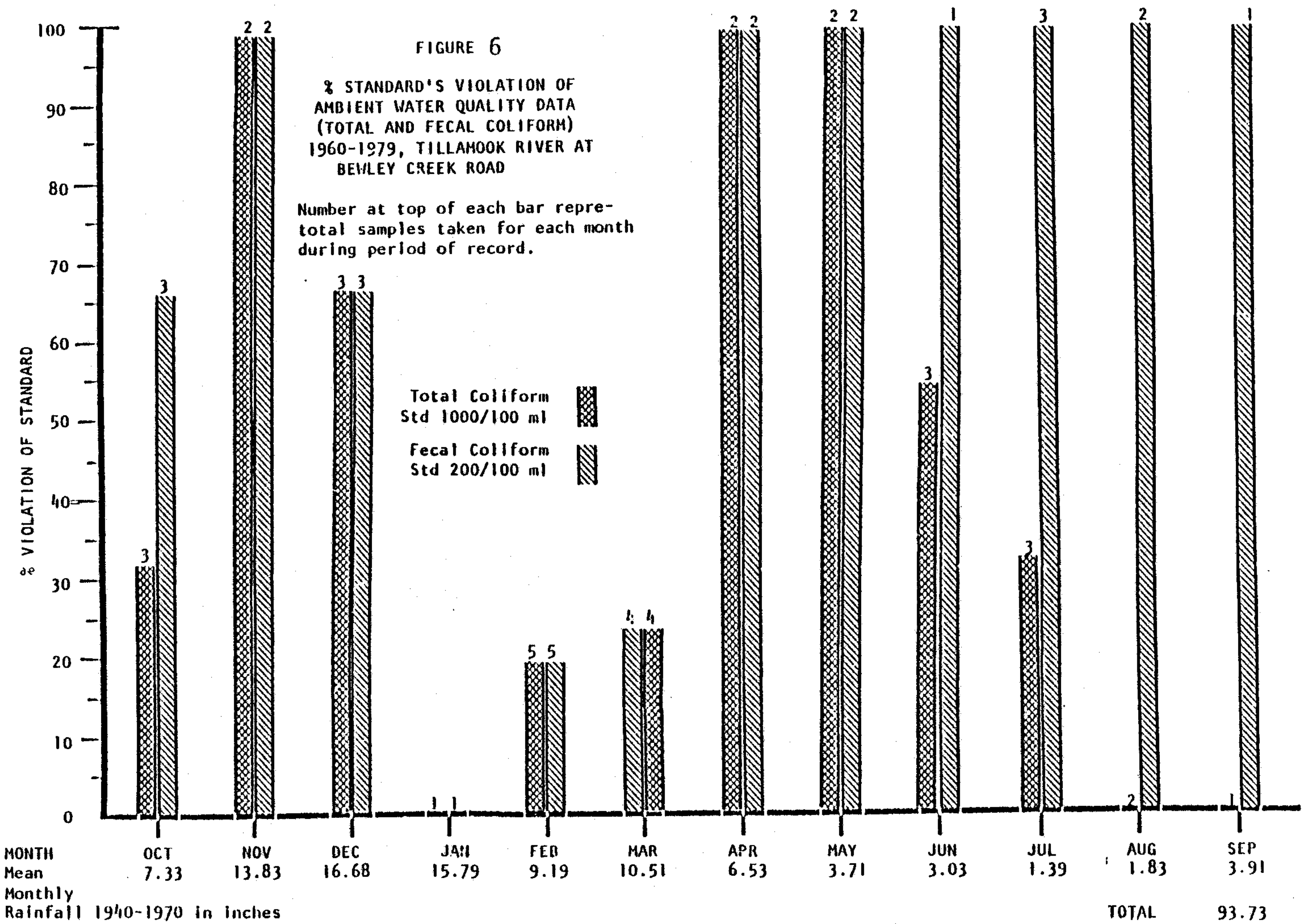


FIGURE 6

% STANDARD'S VIOLATION OF AMBIENT WATER QUALITY DATA (TOTAL AND FECAL COLIFORM) 1960-1979, TILLAMOOK RIVER AT BEWLEY CREEK ROAD

Number at top of each bar repre- total samples taken for each month during period of record.

TABLE 1 AMBIENT WATER QUALITY DATA
(TOTAL AND FECAL COLIFORM) 1979, 1980 FOR TILLAMOOK DRAINAGE BASIN

	Miami Highway 101		Kilchis Highyway 101		Wilson Highway 101		Trask Netarts Road		Tillamook Netarts Road		
	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC	
1979											
JAN.											JAN.
FEB.											FEB.
MAR.											MAR.
APR.											APR.
MAY											MAY
JUNE											JUNE
JULY											JULY
AUG.											AUG.
SEPT.											SEPT.
OCT.	750	750	430	430	930	430	150	150	210/36*	36/36*	OCT.
NOV.	430	150	150	150	230	230			1500/4600*	36/2400*	NOV.
DEC.	1500	750	<30/110*	<30/61*	91	36	430	430	930	430	DEC.
TOTAL											TOTAL
1980											
JAN.	2400	2400	<30	<30	<30	<30	<30	<30	150	73	JAN.
FEB.	930	150	36	<30	36	<30	430	73			FEB.
MAR.	2100	2100	91	<30	91/150*	91/73*			230	36	MAR.
APR.	2400	2400	<30	<30	36	36	<30	<30	930	430	APR.
MAY	390	390	<30	<30	36/150*	36/150*	<30	<30	30	<30	MAY
JUNE	230	230	430	150	430	430	230	230	4600	4600	JUNE
JULY	1500	390	430	430	930	150	230	91	430	73	JULY
AUG.											AUG.
SEPT.											SEPT.
OCT.											OCT.
NOV.											NOV.
DEC.											DEC.
TOTAL											TOTAL

TC = Total Coliform
FC = Fecal Coliform
* = Two Samples Taken

APPENDIX K.

Oregon Department of Environmental Quality, Water Quality Monitoring for Oregon Bays.

Table 1

Summary of Standard Violations For

Tillamook Bay From 1970-1979

(All Bay Stations)

	Total Coliform (#/100 ml)	Fecal Coliform (#/100 ml)	Dissolved Oxygen (mg/l)
Standard	70	14	6.0
Number of Samples (#)	942	942	579
Mean (Arithmetic)	170	48	97
Number of Violations (#)	409	356	-
Percent Violation (%)	43	38	0
Mean Violation	367	120	-
Minimum Violation	75	15	-
Maximum Violation	1100	1100	-
Percent Violation In Shellfish Area	31	16	0
Percent Violation In Channel Area	55	58	0

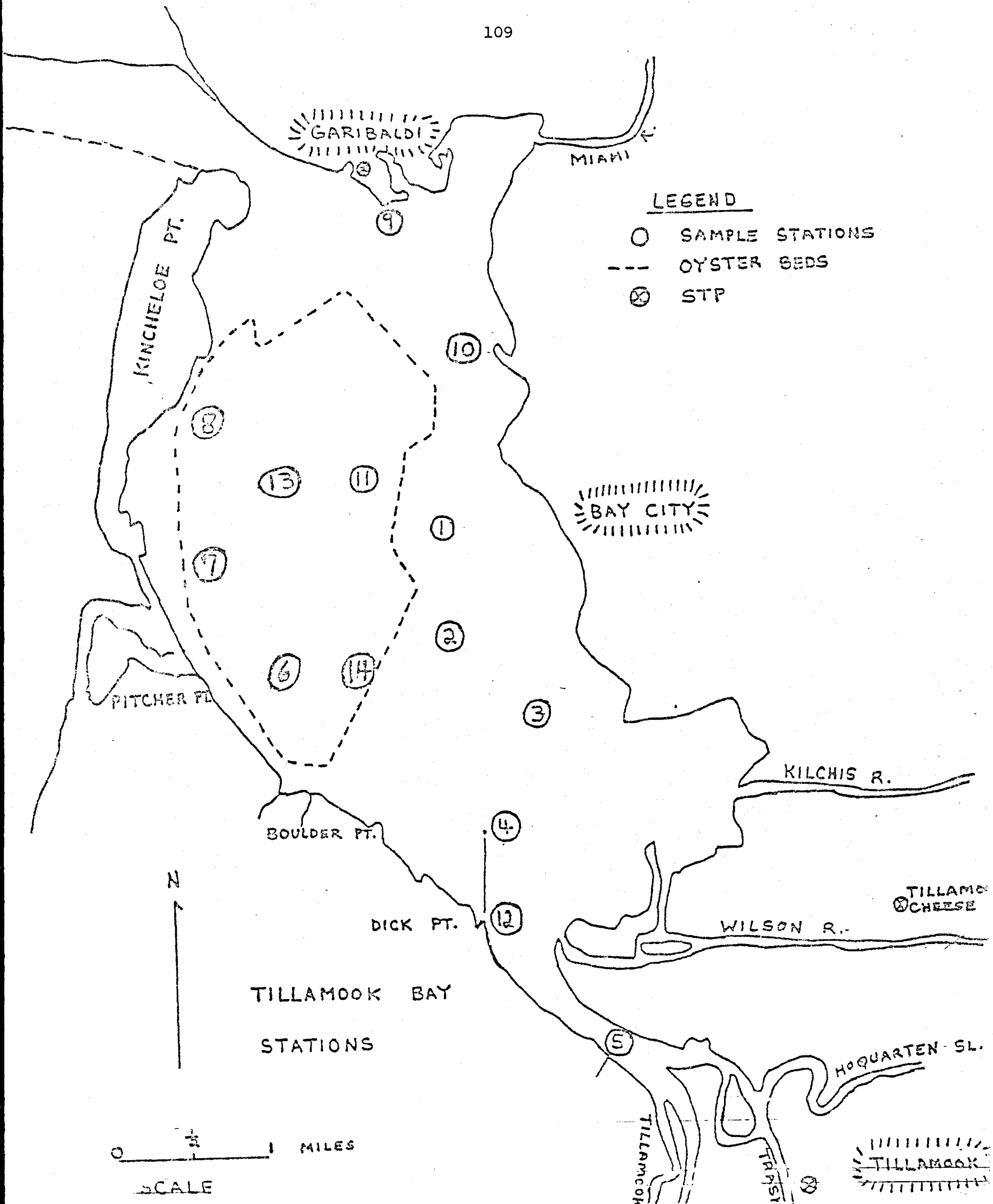

GARIBALDI
MIAMI R.
LEGEND
SAMPLE STATIONS
OYSTER BEDS
STP
KINCHELOE PT.
BAY CITY
PITCHER PT.
KILCHIS R.
BOULDER PT.
DICK PT.
WILSON R.
TILLAMOOK CHEESE
HOQUARTEN SL.
TILLAMOOK
TRASK
TILLAMOOK
N
TILLAMOOK BAY
STATIONS
0
½
1
MILES
SCALE
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Figure 1
Tillamook Bay Aggregated Bacteriological Data
of All Bay Basins
(Arithmetic mean is shown above the log mean,
both are indicated by a horizontal bar)

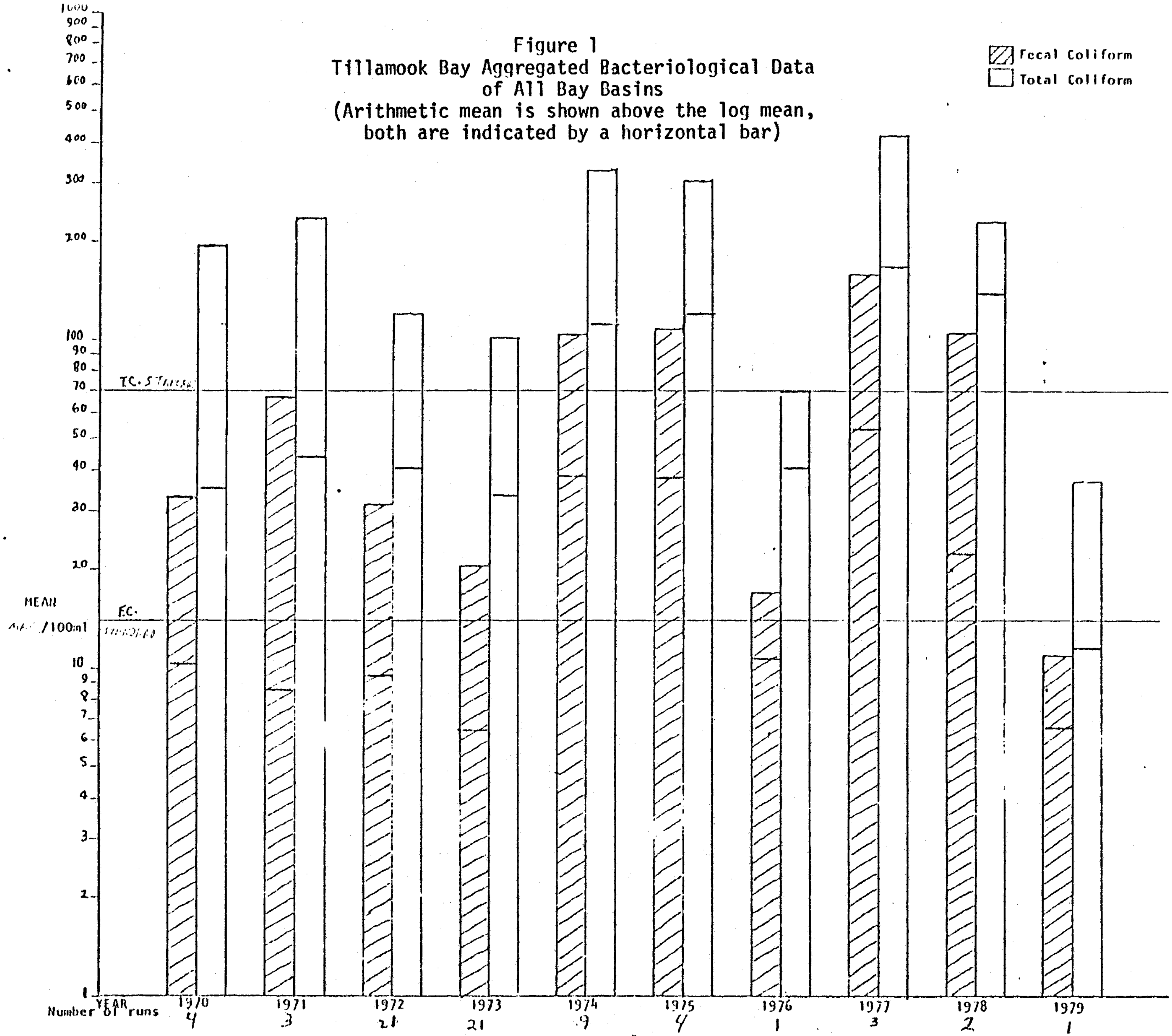


FIGURE 2
Tillamook Bay Monthly Total Coliform Averages
Aggregate Channel Area Stations (5,12,4,3,2,1,10)

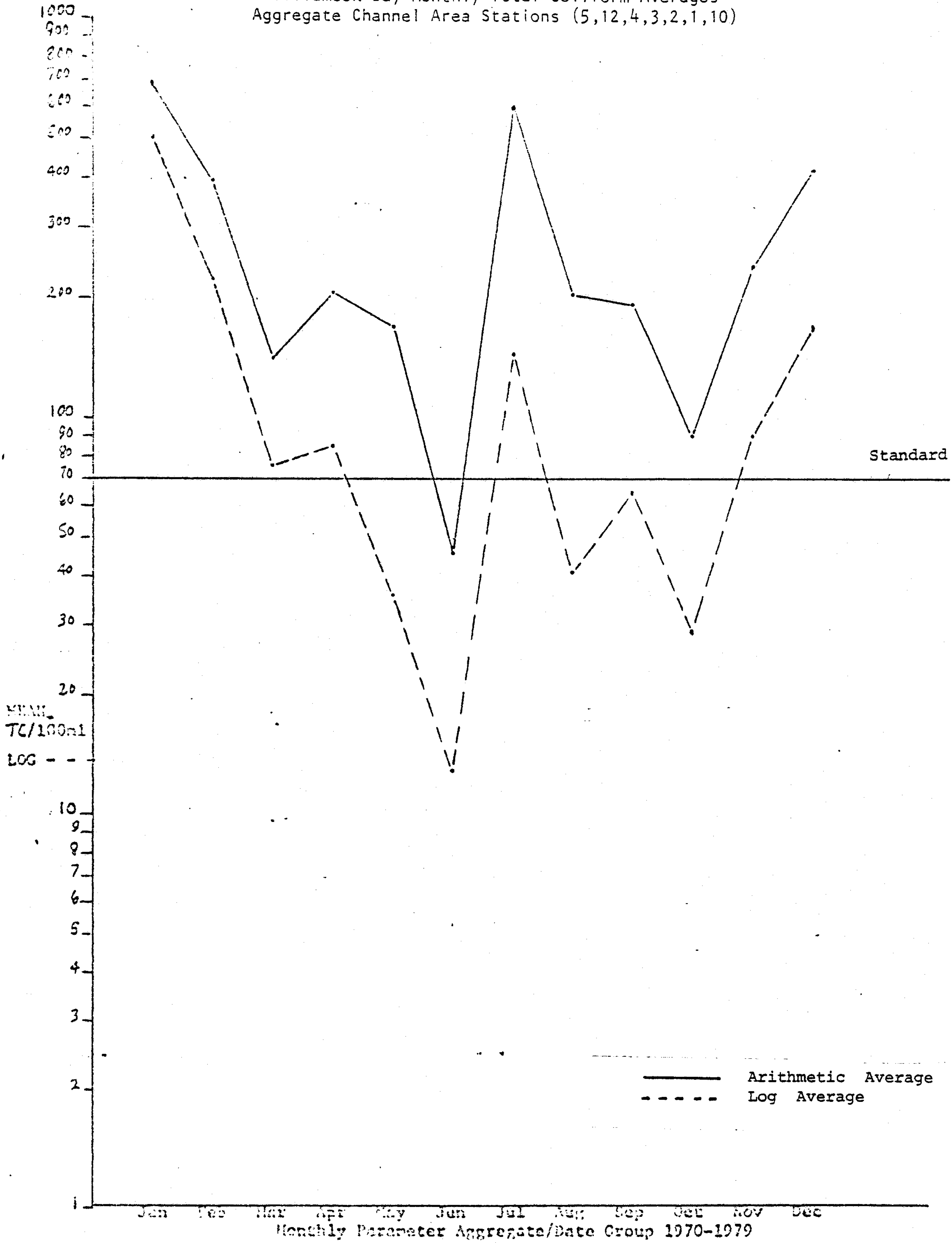


FIGURE 3
Tillamook Bay Monthly Fecal Coliform Averages
Aggregate Channel Area Stations (5,12,4,3,2,1,10)

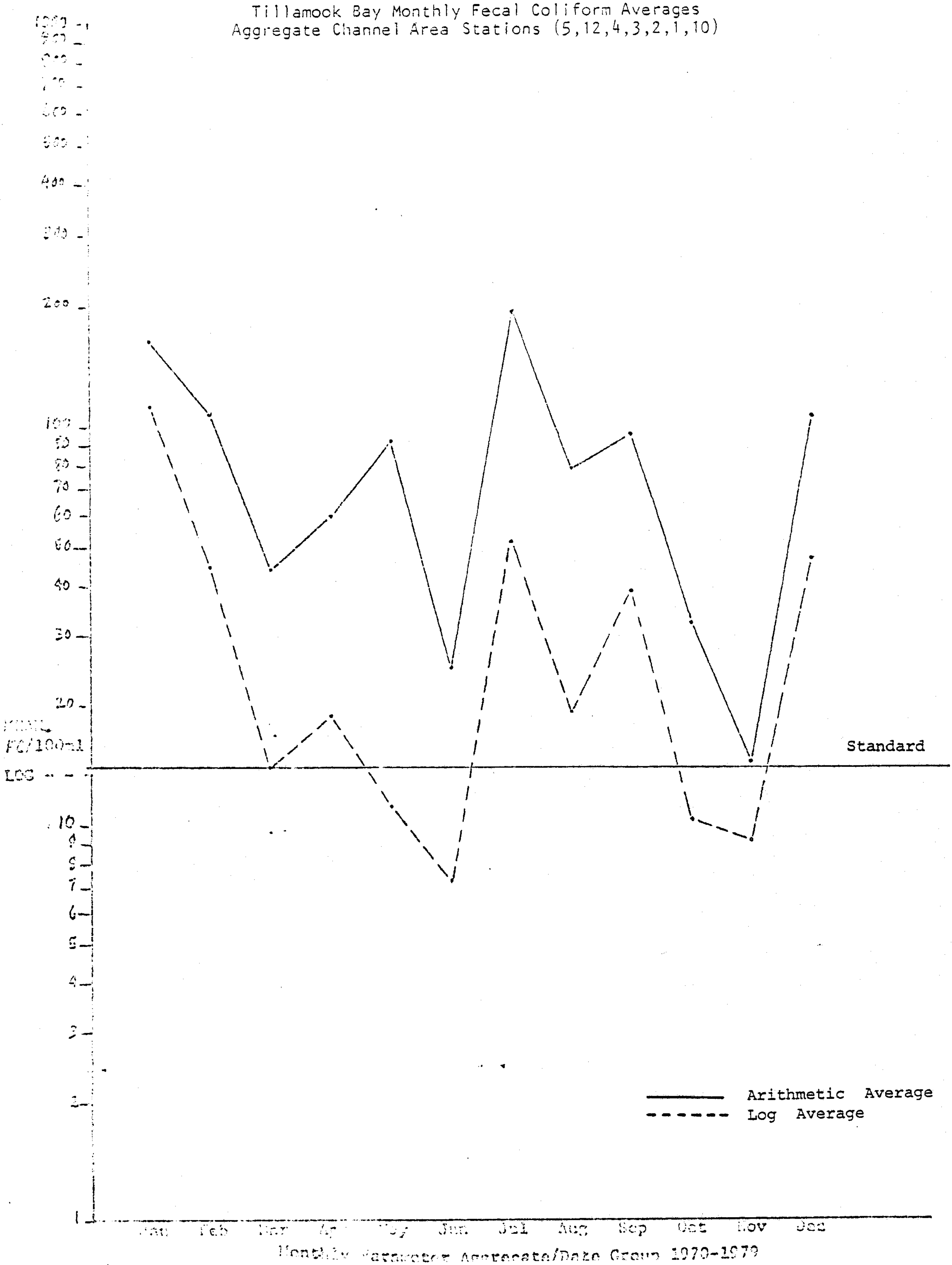


FIGURE 4
Tillamook Bay Monthly Total Coliform Averages
Aggregate Oyster Growing Area Stations (14,6,7,8,13,11)

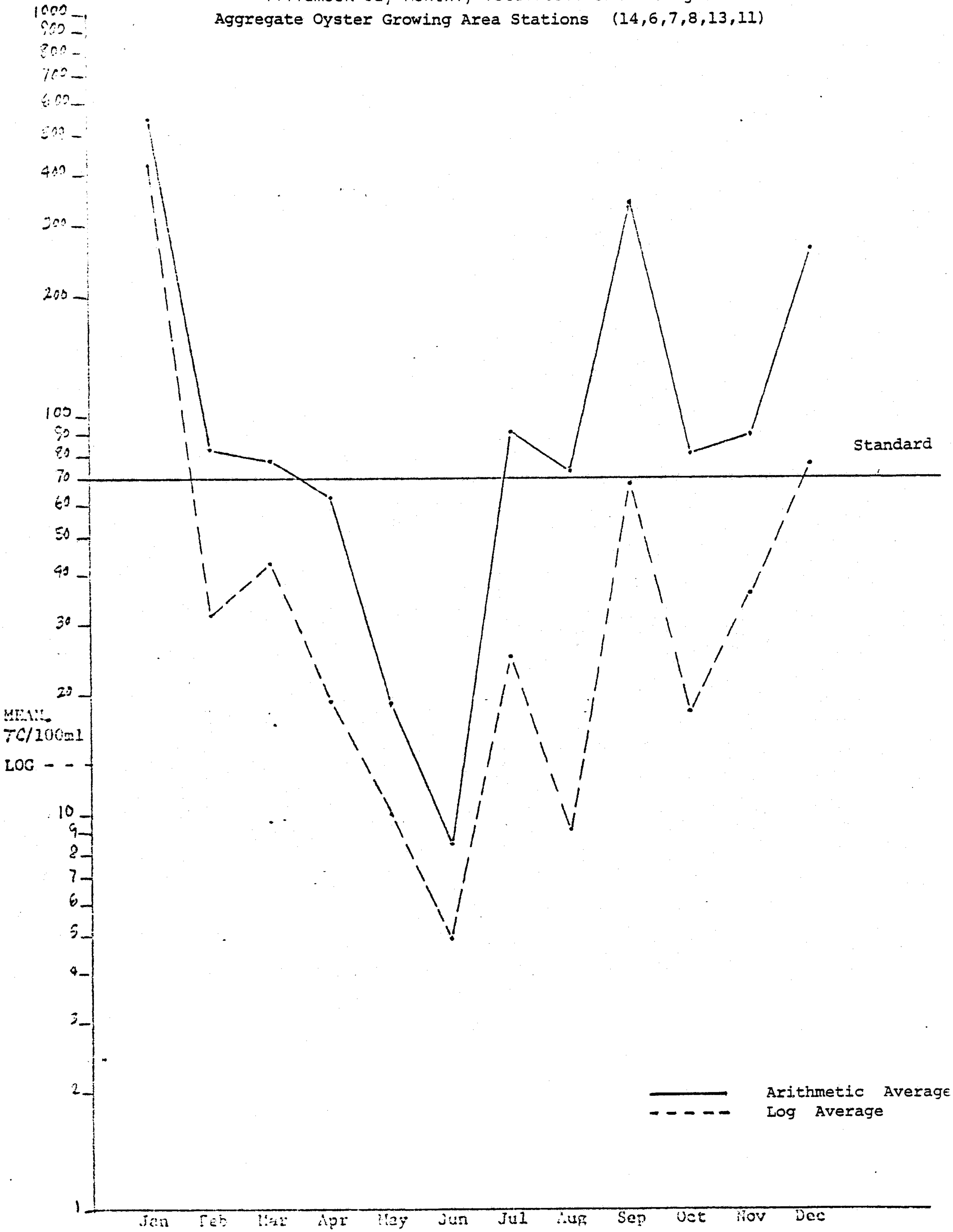


FIGURE 5

Tillamook Bay Monthly Fecal Coliform Averages

Aggregate Oyster Growing Area Stations (14,6,7,8,13,11)

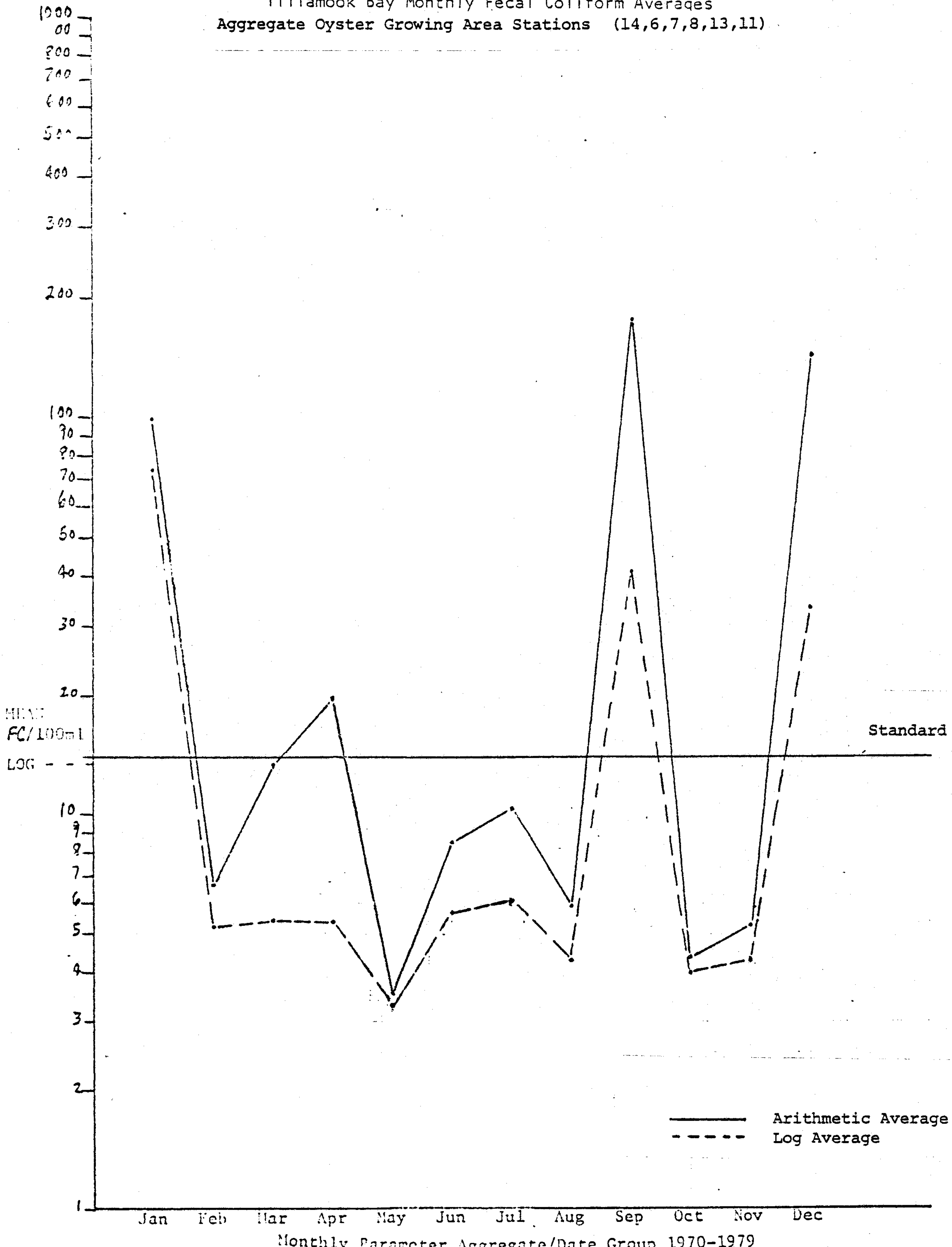


FIGURE 6

Aggregate Dissolved Oxygen vs Time

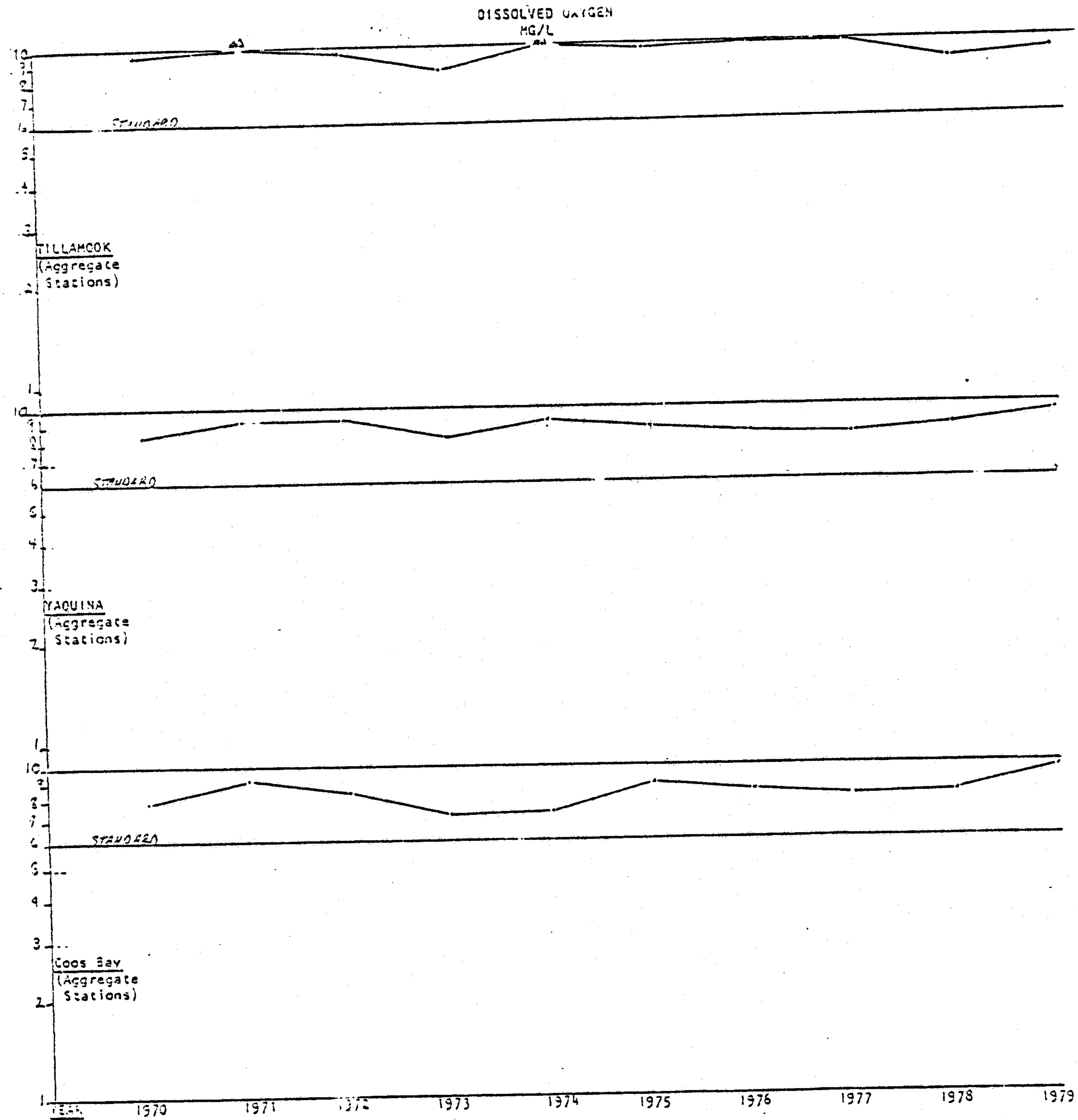


Table 2. Wet Weather and Dry Weather Linear Regression Analysis for Salinity and Temperature and Wilson River Flows versus Fecal Coliform at Three Selected Tillamook Bay Stations Based on past DEQ Ambient Data, 1970 to 1979.

		Wet Weather Period			Dry Weather Period		
Station		S °/oo/FC	T/FC	Fl/FC	S °/oo /FC	T/FC	Fl/FC
12	N =	30	30	30	9	9	9
	R =	-0.21	-0.39	+ 0.10	- 0.27	- 0.41	- 0.03
6	N =	39	43		13	13	
	R =	- 0.29	- 0.04		+ 0.25	- 0.05	
14	N =	24	24		7	7	
	R =	- 0.52	- 0.18		- 0.83	- 0.55	

N = Number of samples
R = Correlation coefficient
$S^{o}/00$ = Salinity parts per thousand
T = Temperature, centigrade
Fl = Wilson River Flow, cubic feet per second
FC = Fecal Coliform MPN per 100 ml.

Wet weather = October through April
Dry weather = May through September

* As Table 3 shows, no clear cut correlation is apparent. It appears that salinity at Station 14 may correlate with fecal coliform during the dry period. But, since May to September is a period when the bay generally meets water quality standards and is not subject to high river inflows, this correlation appears to have limited usefulness.

APPENDIX L.

Food and Drug Administration, 1975. Comprehensive Sanitary Survey of Tillamook Bay, Oregon in November, 1974. Northeast Technical Services Unit, Davisville, Rhode Island.

SUMMARY AND CONCLUSIONS

Sources of Pollution

1. The predominant sources of pollution were sewage treatment plants and dairy herds. Both sources adversely affect the water quality of the tributaries and Bay in wet and dry weather.
2. The sewage treatment plants do not have sufficient inherent reliability or a high enough degree of treatment to provide assurance that they will continuously prevent fecal contamination of the Bay and its shellfish resources. The treatment plants are not attended throughout a 24-hour period and the chlorination systems are not equipped with adequate alarms to indicate a treatment failure. Furthermore, they are not sufficiently remote, hydrographically, from harvest areas to provide time and distance for adequate dieoff and dilution of microorganisms. From a hydrographic standpoint, the water volume available in the Bay (especially during low tide) is insufficient to establish an adequate "buffer zone". A buffer zone should be available to counteract the variations in sewage treatment associated with peak sewage flow and varying sewage quality.
3. Fecal wastes from numerous dairy herds contaminate the tributaries and subsequently the Bay, mainly during wet weather runoff. However, bacterial sampling of the tributaries and the Bay indicates that feces from the cows also enter the tributaries even in dry weather.

<u>Bacteriological Studies - Water and Shellfish</u>

1. Tillamook Bay and its tributary streams are contaminated by fecal wastes regardless of weather and tide conditions. The results of this study support conclusions of a previous study by the State of Oregon which has shown that all of Tillamook Bay and its tributaries undergo fecal contamination regardless of season, weather, and tidal conditions.
2. Field observations and adjunct bacteriological tests indicate that a substantial percent of total and fecal coliform organisms recovered through bacteriological examination of treatment plant effluents, tributary waters, bay waters, and shellfish were of human and bovine origin. Adjunct bacteriological analyses included: IMViC tests, fecal strep differential tests, and tests for salmonellae organisms.
3. *E. coli* was the predominant fecal coliform biotype isolated from bay and stream samples suggesting relatively recent fecal contamination.
4. The recovery of *Salmonella* organisms from water at two stations in the conditionally approved area indicates fecal contamination, and a potential health hazard.
5. Levels of indicator organisms found in shellfish harvested from the conditionally approved area exceed NSSP Wholesale Market bacteriological standards.

6. Klebsiella was the predominant fecal coliform* biotype isolated from the oyster samples. Causes of the high levels of this biotype relative to E. coli were not determined by the study; however, Klebsiella was always recovered in the presence of E. coli. Since these organisms fermented lactose at 44.5°C in 24 hours and met all other criteria of the fecal coliform indicator group, the Klebsiella recovered in this study were considered to be of fecal orgin.

Classification Aspects

1. Tillamook Bay is improperly classified according to NSSP standards and guidelines. Relocation of the Bay City-Dick Point permanent closure line according to growing area standards would permit harvesting of a limited area only after prolonged dry weather and simultaneous good chlorination practices.
2. At several of the approved area stations, the total coliform growing area standard of 70 per 100 ml was exceeded by a margin which cannot be considered as reasonably safe. Individual water samples from such approved area stations yielded total coliform MPN's higher than 1,100 per 100 ml, and it was not unusual to find median MPN values well into the hundreds. Such high bacterial indicator levels occurred regardless of the tide and weather conditions. Some parts of the oyster lease area could be considered safe for direct marketing only after prolonged dry weather conditions and simultaneous good chlorination of domestic sewage.

*Isolated from E.C. gas positive tubes incubated at 24 hours at 44.5°C and further identified through appropriate biochemical tests.

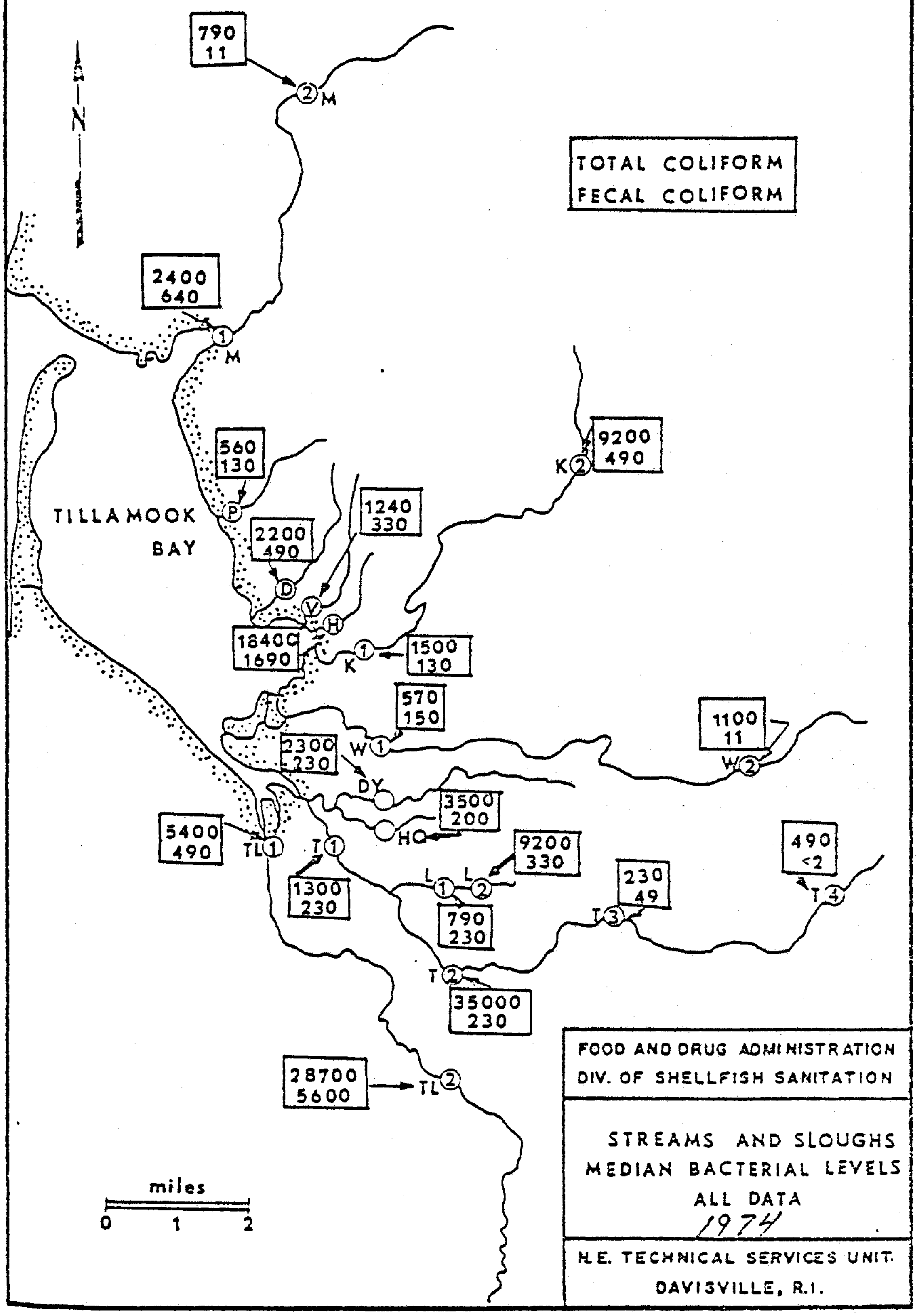
RECOMMENDATIONS

Based upon the results of this study and supportive data from a previous study of Tillamook Bay conducted by the State of Oregon, the following recommendations are submitted:

1. Tillamook Bay should be immediately closed to shellfish harvesting until the area is properly classified and both water quality and shoreline survey data demonstrate that the conditionally approved area meets NSSP standards and criteria.
   a. The present permanent closure from Dick Point to Bay City should be relocated.
   b. Because of the random high bacterial levels found, sampling should be done at a minimum of once per week at two or three key stations, and sampling frequency should be increased with adverse sample results, or adverse pollution (e.g., rainfall and STP failures) conditions, as they are found.
   c. If the area is reopened, it should be closed for direct marketing immediately upon the finding of adverse conditions and resulting water quality degradation and not reopened until the water is of satisfactory quality, and the shellfish have had time to purify.
2. If the above conditions cannot be met, Tillamook Bay should be closed for direct marketing of shellfish. Two alternatives are available for consideration:

a. Relay shellfish harvested from Tillamook Bay to "approved" growing area waters, or

b. Depurate shellfish harvested from Tillamook Bay in controlled purification (depuration) systems before marketing.


TOTAL COLIFORM
FECAL COLIFORM
N
TILLAMOOK BAY
790
11
M 2
2400
640
M 1
560
130
P
2200
490
D
1240
330
V
H
18400
1690
L
1500
130
K 1
9200
490
K 2
570
150
W 1
1100
11
W 2
2300
230
DY
3500
200
HQ
5400
490
TL 1
T 1
1300
230
9200
330
L 1
L 2
790
230
230
49
T 3
490
<2
T 4
T 2
35000
230
28700
5600
TL 2
miles
0
1
2
FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
STREAMS AND SLOUGHS
MEDIAN BACTERIAL LEVELS
ALL DATA
1974
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.

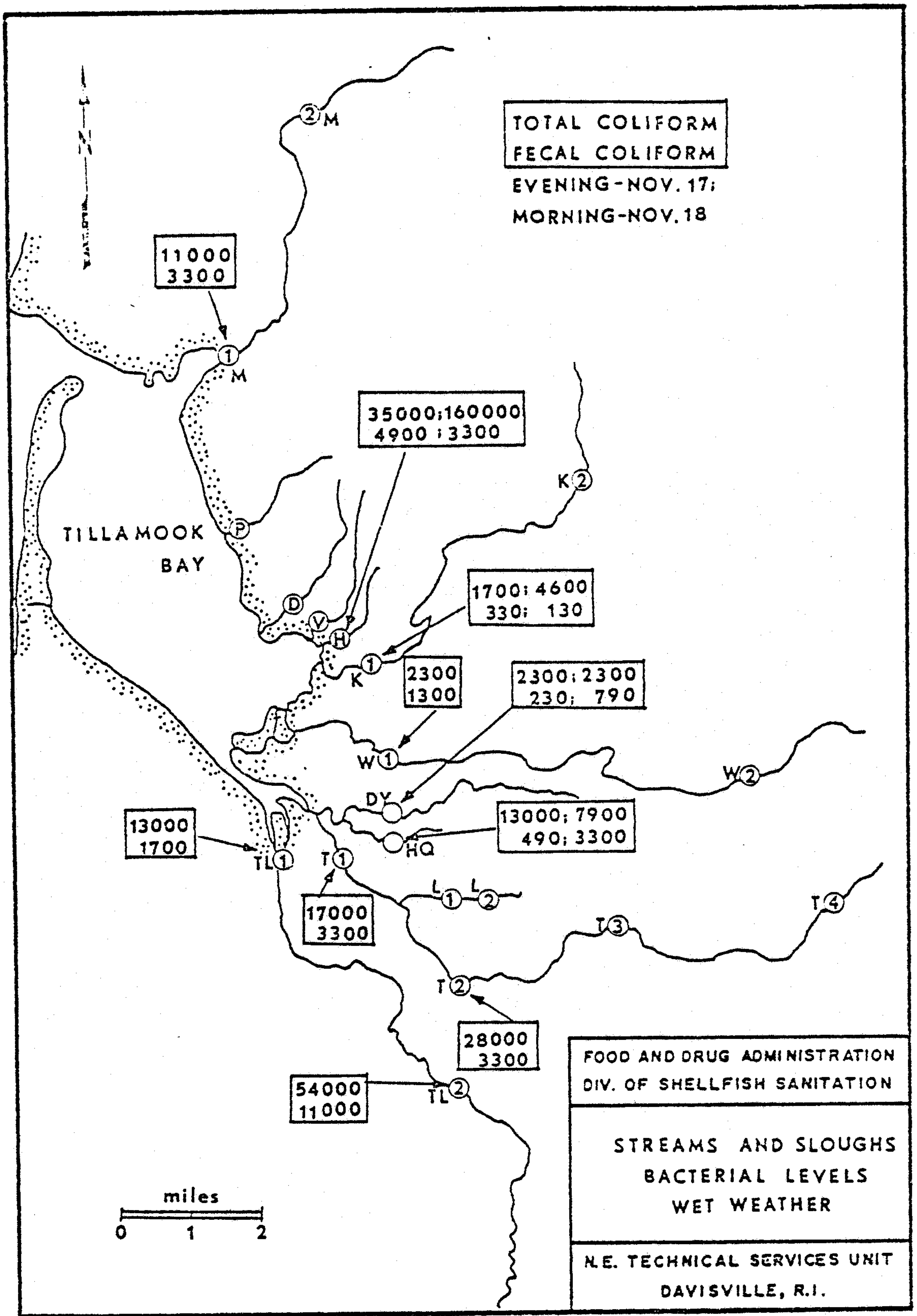

TOTAL COLIFORM
FECAL COLIFORM
EVENING-NOV. 17;
MORNING-NOV. 18
TILLAMOOK
BAY
11000
3300
35000;160000
4900 ; 3300
1700; 4600
330; 130
2300
1300
2300; 2300
230; 790
13000
1700
13000; 7900
490; 3300
17000
3300
28000
3300
54000
11000
M
K
W
DY
HQ
TL
T
L
P
D
V
H
miles
0
1
2
FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
STREAMS AND SLOUGHS
BACTERIAL LEVELS
WET WEATHER
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.

FIGURE 7

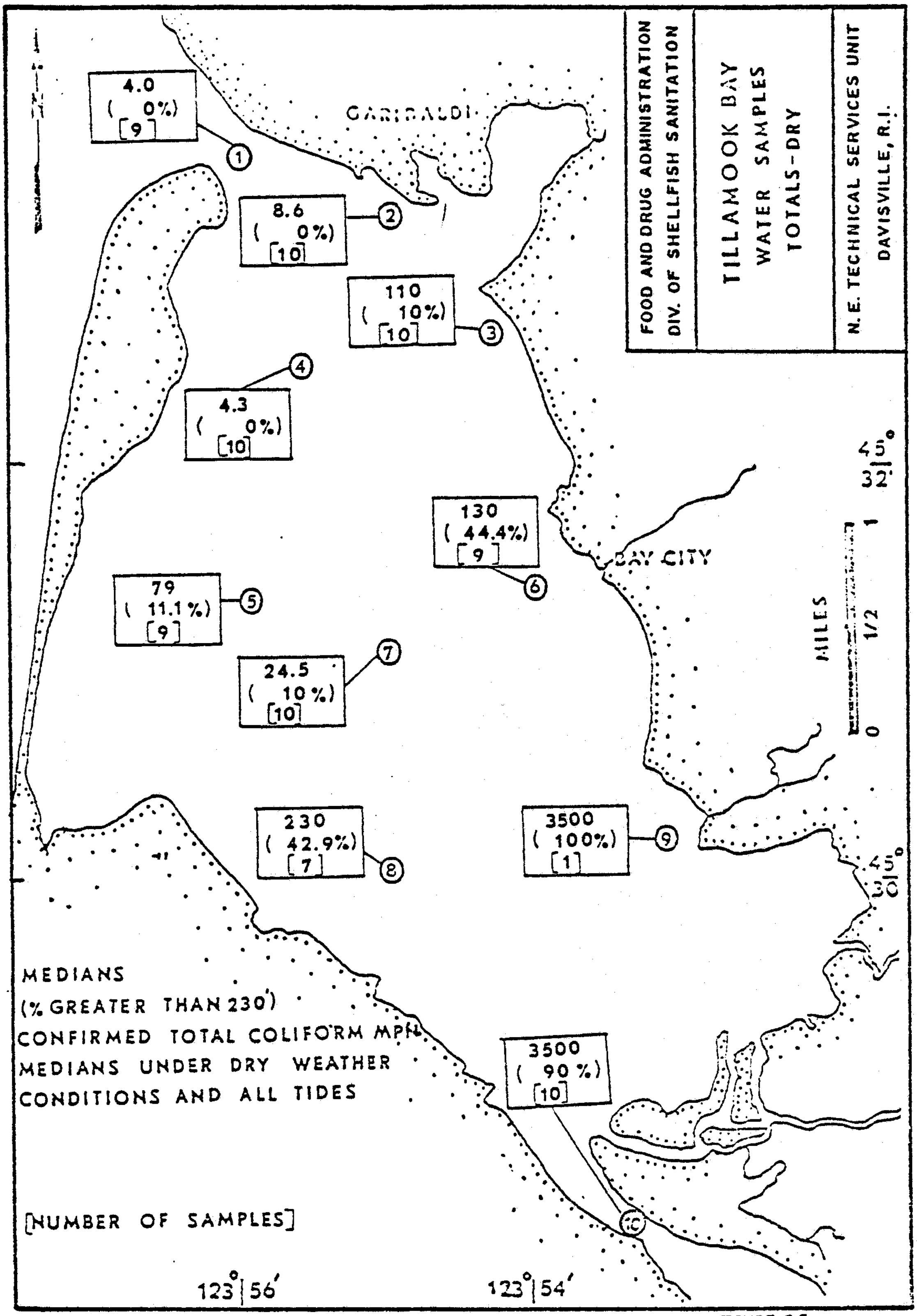

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
WATER SAMPLES
TOTALS-DRY
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
4.0 (0%) [9] ①
8.6 (0%) [10] ②
110 (10%) [10] ③
4.3 (0%) [10] ④
79 (11.1%) [9] ⑤
130 (44.4%) [9] ⑥
24.5 (10%) [10] ⑦
230 (42.9%) [7] ⑧
3500 (100%) [1] ⑨
3500 (90%) [10] ⑩
MILES
0
1/2
1
45° 32'
45° 30'
123° 56'
123° 54'
MEDIANS
(% GREATER THAN 230)
CONFIRMED TOTAL COLIFORM MPN
MEDIANS UNDER DRY WEATHER
CONDITIONS AND ALL TIDES
[NUMBER OF SAMPLES]

FIGURE 25

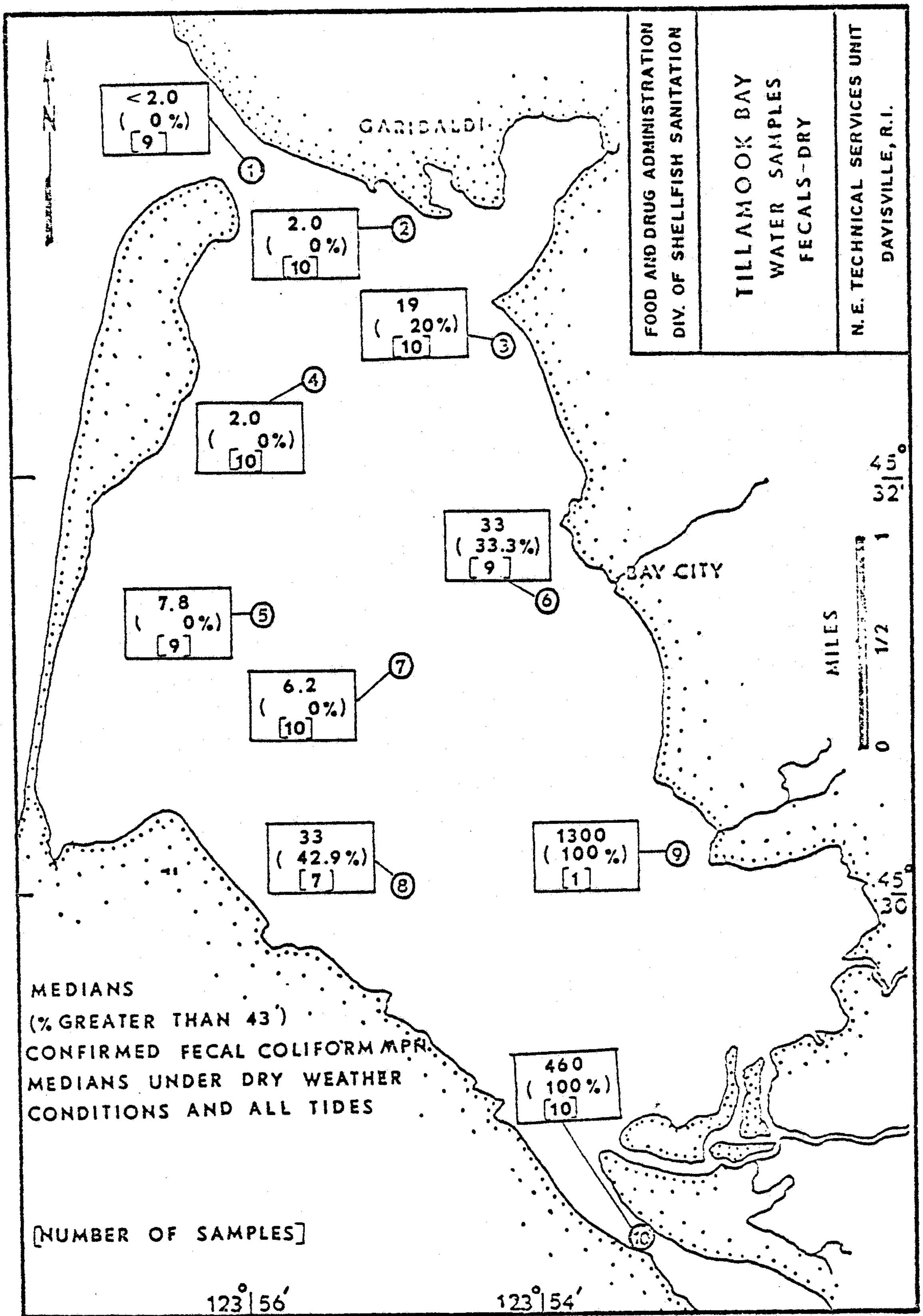

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
WATER SAMPLES
FECALS-DRY
N. E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
< 2.0 (0 %) [9] ①
2.0 (0%) [10] ②
19 (20%) [10] ③
2.0 (0%) [10] ④
7.8 (0%) [9] ⑤
33 (33.3%) [9] ⑥
6.2 (0%) [10] ⑦
33 (42.9%) [7] ⑧
1300 (100%) [1] ⑨
460 (100%) [10] ⑩
MILES
0 1/2 1
45° 32'
45° 30'
123° 56'
123° 54'
MEDIANS
(% GREATER THAN 43)
CONFIRMED FECAL COLIFORM MPN
MEDIANS UNDER DRY WEATHER
CONDITIONS AND ALL TIDES
[NUMBER OF SAMPLES]

FIGURE 26

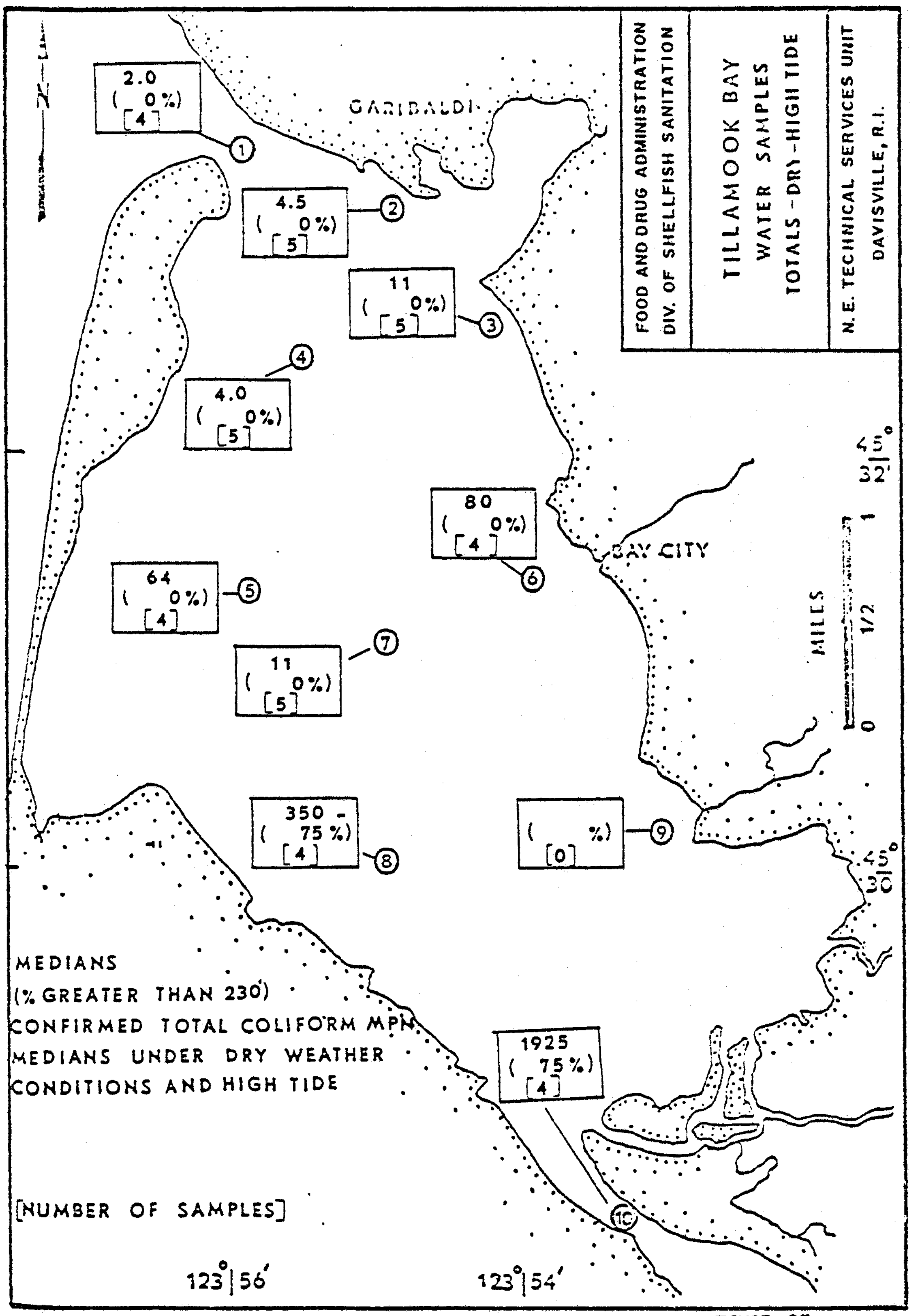

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
WATER SAMPLES
TOTALS - DRY - HIGH TIDE
N. E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
2.0 (0 %) [4] 1
4.5 (0 %) [5] 2
11 (0 %) [5] 3
4.0 (0 %) [5] 4
64 (0 %) [4] 5
80 (0 %) [4] 6
11 (0 %) [5] 7
350 - (75 %) [4] 8
(%) [0] 9
1925 (75 %) [4] 10
MILES
0
1/2
1
45° 32'
45° 30'
MEDIANS
(% GREATER THAN 230)
CONFIRMED TOTAL COLIFORM MPN
MEDIANS UNDER DRY WEATHER
CONDITIONS AND HIGH TIDE
[NUMBER OF SAMPLES]
123° 56'
123° 54'

FIGURE 27

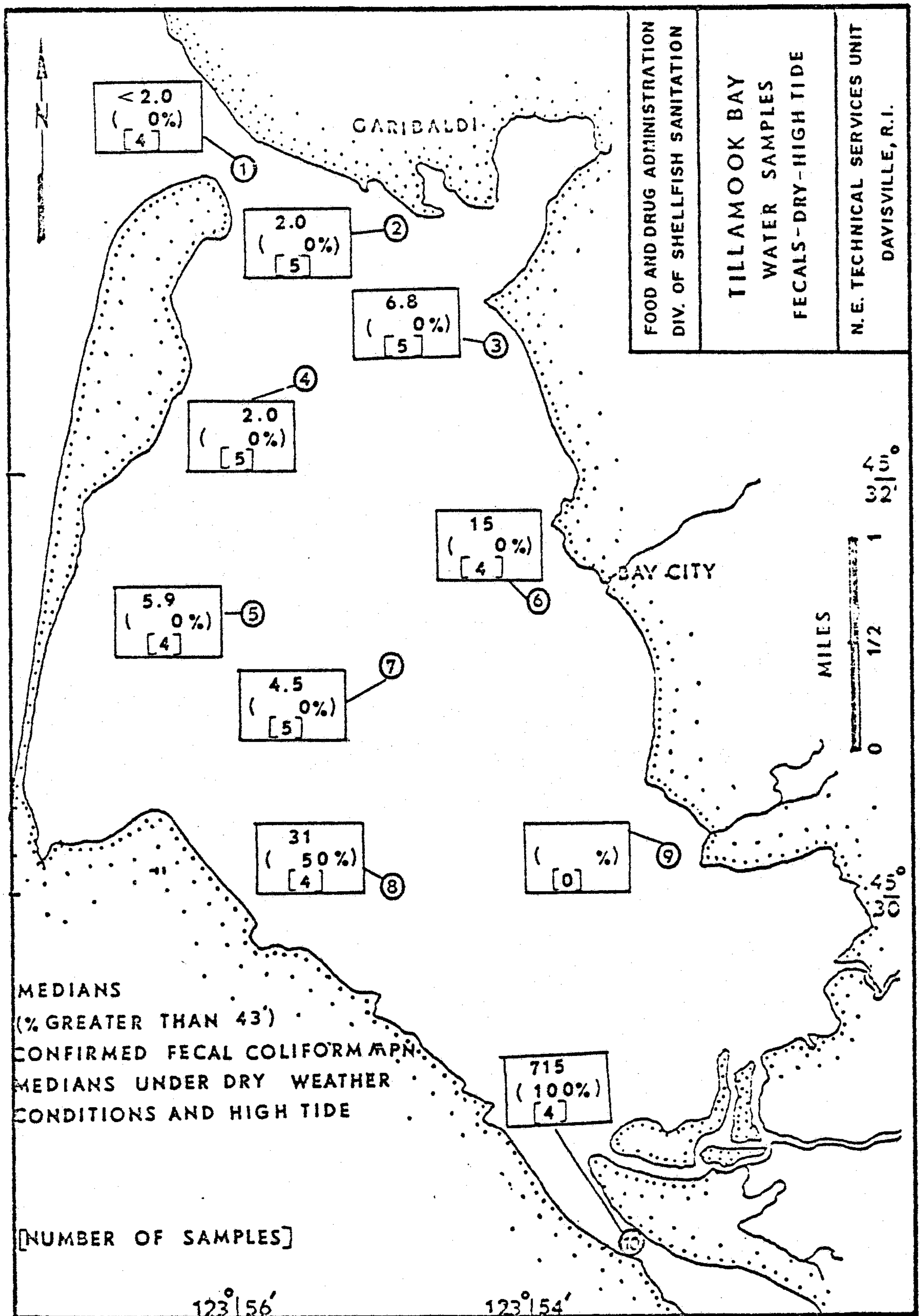

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
WATER SAMPLES
FECALS-DRY-HIGH TIDE
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
N
MILES
0
1/2
1
45° 32'
45° 30'
<2.0 (0%) [4] ①
2.0 (0%) [5] ②
6.8 (0%) [5] ③
2.0 (0%) [5] ④
5.9 (0%) [4] ⑤
15 (0%) [4] ⑥
4.5 (0%) [5] ⑦
31 (50%) [4] ⑧
(%) [0] ⑨
715 (100%) [4] ⑩
MEDIANS
(% GREATER THAN 43)
CONFIRMED FECAL COLIFORM MPN
MEDIANS UNDER DRY WEATHER
CONDITIONS AND HIGH TIDE
[NUMBER OF SAMPLES]
123° 56'
123° 54'

FIGURE 28

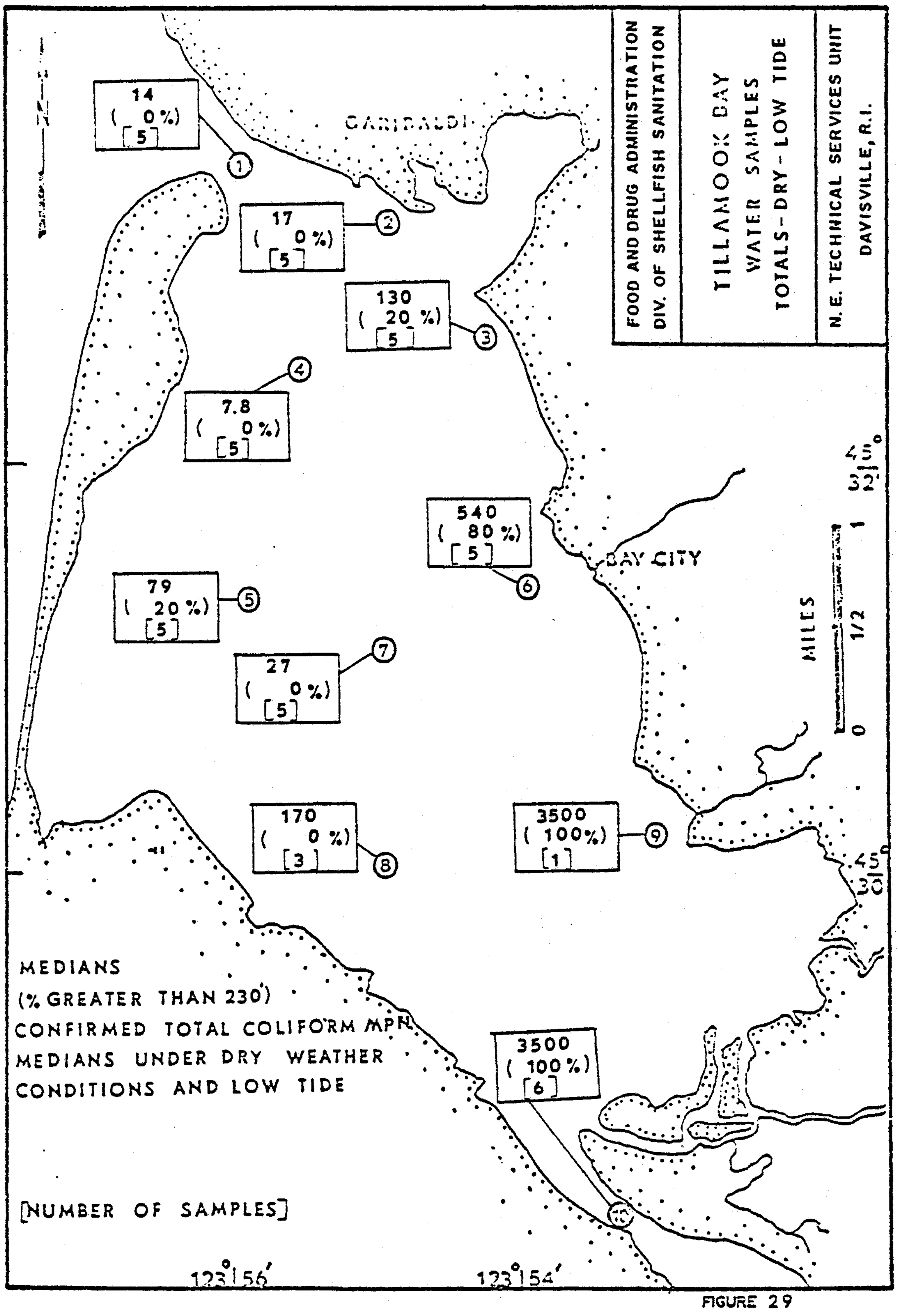

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
WATER SAMPLES
TOTALS - DRY - LOW TIDE
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
14 (0 %) [5] ①
17 (0 %) [5] ②
130 (20 %) [5] ③
7.8 (0 %) [5] ④
79 (20 %) [5] ⑤
540 (80 %) [5] ⑥
27 (0 %) [5] ⑦
170 (0 %) [3] ⑧
3500 (100%) [1] ⑨
3500 (100 %) [6]
MILES
0
1/2
1
45° 32'
45° 30'
123° 56'
123° 54'
MEDIANS
(% GREATER THAN 230)
CONFIRMED TOTAL COLIFORM MPN
MEDIANS UNDER DRY WEATHER
CONDITIONS AND LOW TIDE
[NUMBER OF SAMPLES]

FIGURE 29

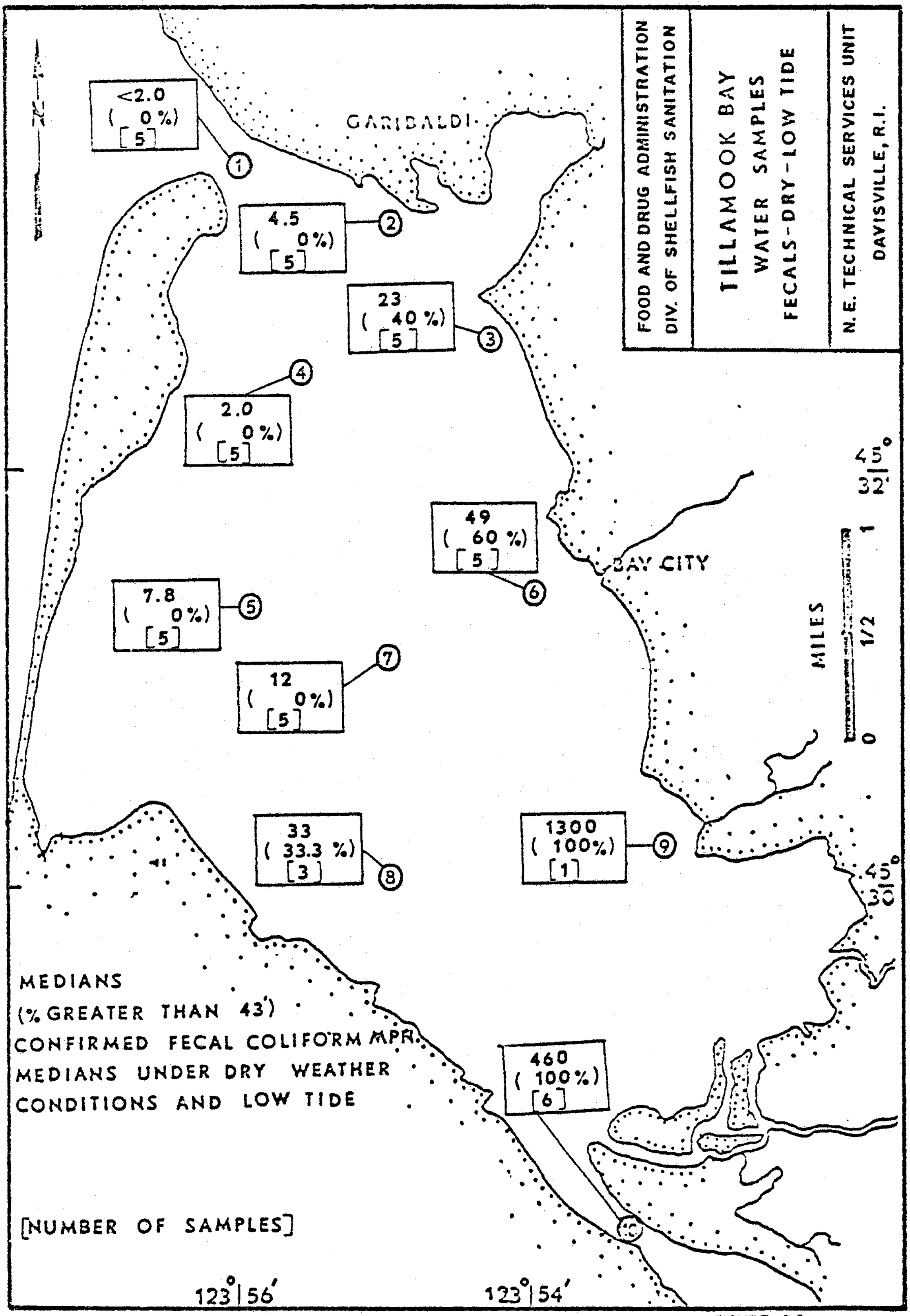

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
WATER SAMPLES
FECALS-DRY-LOW TIDE
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
<2.0 (0 %) [5] ①
4.5 (0 %) [5] ②
23 (40 %) [5] ③
2.0 (0 %) [5] ④
7.8 (0 %) [5] ⑤
49 (60 %) [5] ⑥
12 (0 %) [5] ⑦
33 (33.3 %) [3] ⑧
1300 (100%) [1] ⑨
460 (100%) [6] ⑩
MILES
0 1/2 1
45° 32'
45° 30'
123° 56'
123° 54'
MEDIANS
(% GREATER THAN 43)
CONFIRMED FECAL COLIFORM MPN
MEDIANS UNDER DRY WEATHER
CONDITIONS AND LOW TIDE
[NUMBER OF SAMPLES]

FIGURE 30

APPENDIX M.

Stott, R.S., 1975. Oregon State Shellfish Sanitation Program Review 1974-1975. Food and Drug Administration, Region X, Seattle, Washington.

TILLAMOOK BAY

Three periods of water sampling were conducted from July, 1974 to July, 1975 by Oregon State Department of Environmental Quality.

The August 18, 1974 water sampling survey disclosed that all of the twelve samples taken from the approved area met the approved growing area criteria for total coliform and fecal coliform. (The coliform median MPN of water does not exceed 70 per 100 ml; and not more than 10% of the samples ordinarily exceed an MPN of 230 per 100 ml. The fecal coliform median MPN of the water does not exceed 14 per 100 ml., and not more than 10% of the samples ordinarily exceed an MPN of 43 per 100 ml. Both 10% ranges are based on the 5 tube 3 dilution test.).

During the December 3, 1974 sampling, one of twelve samples taken from the approved area did not meet the approved total coliform criteria. Three of the twelve samples did not meet the fecal coliform criteria.

The March 3, 1975 disclosed five of seven samples taken from the approved area did not meet the total coliform criteria for an approved area. Three of these seven samples did not meet the fecal coliform criteria.

The seven July 14 - 15, 1975 samples taken from the approved area met both total and fecal coliform criteria.

As can be noted from these 38 samples from the approved area, the oyster lease area continues to be influenced periodically with pollution.

The pollution sources and problems remain the same as previously reported in the Oregon State Shellfish Sanitation Program Reviews from 1971 through 1974.

In November, 1974, FDA, the Oregon State Division of Health, Oregon State Department of Environmental Quality, and FDA participated in a joint comprehensive study of Tillamook Bay. The study was designed for evaluation of growing area during the wet weather conditions. The report of this study is in the final stages of preparation.

SUMMARY

One purpose of this abbreviated review is to determine what actions have been taken to accomodate recommendations made in previous reports. Therefore, a list of these recommendations made in the 1973-1974 evaluation report is found below. The response is listed as Part (a) of the individual recommendations.

It was recommended in the 1974-1975 evaluation that:

1. The 1972 Memorandum of Agreement be complied with in that DEQ should supply the sewage treatment records for those plants affecting shellfish growing areas.
   (a) Recently DEQ has been supplying reasonably complete records of the performance of the plants. Improvement could be made upon the speed with which records are sent to the Division of Health. (It was reported recently, (1/14/76) that DEQ is supplying bacteriological sewage treatment records within two days after completion of the evaluation.)
2. Action be taken to insure compliance with the agreement or Tillamook Bay be closed until all parties fulfill the obligations of the agreement.
   (a) There appears to be improved monitoring of plants by DEQ, however, the minimum level of bacteriological monitoring samples outlined Waste Discharge Permit is

not being followed. The Division of Health is not monitoring rainfall so that Tillamook Bay or Yaquina Bay can be closed after an excess of 2 inches of rain in a 24 hour period as per the 1972 Agreement.

3. The funding of the program be examined and more funds be alloted to the program.
   (a) The Division of Health has made an analysis of present cost but no additional money or manpower has been requested.
4. A comprehensive wet weather survey be done in Tillamook Bay.
   (a) This study was done November, 1974 by cooperative effort of Division of Health, DEQ and FDA.
5. The cumulative effect of rainfall should be taken into consideration with supporting data indicating a closure and opening criteria of the approved area in Yaquina Bay. (This could also be said of Tillamook Bay).
   (a) This has not been done.
6. Establish performance criteria for each of the major sources of contamination.
   (a) This has been done for all major waste discharges by means of the DEQ Waste Discharge Permit.
7. A system be developed that the Division of Health receives sewage treatment performance records on at least a weekly basis for Yaquina Bay. (This should also be the procedure for all other shellfish growing areas.)

APPENDIX N.

Food and Drug Administration, 1976. Tillamook Bay, Oregon, Pollution Source Evaluation with Classification and Management Consideration, May, 1976. Northeast Technical Services Unit, Davisville, Rhode Island.

TILLAMOOK BAY, OREGON

CONCLUSIONS

Based upon the results of the May 1976 study; the study conducted by NTSU entitled, "Tillamook Bay, Oregon - Comprehensive Sanitary Survey - November 1974"; and an analyses of State of Oregon collected data from July 16, 1973, until April 2, 1974, and summarized in the November 1974 study, the following conclusions are made concerning the shellfish growing area water quality of Tillamook Bay:

1. In order to utilize shellfish for fresh or frozen use directly from Tillamook Bay, Oregon, the lower part of the Bay must be classified as conditionally approved according to criteria of the National Shellfish Safety Program. The alternatives for consideration of shellfish utilization are relaying and depuration.
2. The water quality in the lower part of Tillamook Bay is good under conditions of little rainfall induced runoff and ideal sewage treatment plant operation as shown by the FDA studies; however, the water quality does not meet approved shellfish growing area criteria following heavy rainfall and runoff as shown by the November 1974 FDA study and the state data.
3. Five sewage treatment plants are located in the immediate vicinity of the Tillamook Bay shellfish growing area and all plants can pollute the growing area with improperly

treated sewage in time periods ranging from 1/2 to 3 1/2 hours following malfunction of critical units. Because of the lack of continuous attendance and the lack of critical unit malfunction alarms, the plants can discharge improperly treated sewage for time periods ranging from 8 to 48 hours before being discovered. That would permit the harvest of sewage contaminated shellfish.

4. Fecal material from concentrated numbers of dairy cattle is constantly introduced into Tillamook Bay via streams and sloughs. During dry weather, the fecal material is diluted sufficiently to allow shellfish harvesting. However, during wet weather, the water quality does not meet approved growing area criteria because much more fecal material is washed from pasture areas and fields into the streams and sloughs and rapidly finds it way into Tillamook Bay.

5. There is a minimum of dilution of flows containing fecal material from streams, sloughs, and sewage treatment plant effluents into Tillamook Bay because of the shallow water depths generally ranging from 1 to 5 feet at low tides with channel depths generally in the 7 to 10 feet depth range.

RECOMMENDATIONS

In order to operate the Tillamook Bay shellfish growing area as a conditionally approved area, basic controls, guidelines, notification procedures, understandings of pollution potentials, and cooperation among governmental agencies and industry must be established. The following recommendations are made:

1. Performance standards must be established for each of the five sewage treatment plants. Performance standards are minimum operation conditions that must exist at each plant in order for the water quality in the conditionally approved growing area to meet approved shellfish growing area criteria.
2. After performance standards are set, continuous monitoring of each plant must be performed so that an alert will be given when performance standards are not met. The monitoring must include alarm systems which will be transmitted to a location where personnel are on duty at all times such as police and fire stations.
3. Memoranda of Understanding must be developed among the waste treatment plant management, state water pollution control officials, state shellfish control officials and industry so that the industry can stop harvesting shellfish when performance standards are not met and before the growing area becomes polluted.

4. Principles established in the Technical Bulletin, "Protection of Shellfish Water", EPA 430/9-74-010, July 1974 by the U. S. Environmental Protection Agency must be used to ensure maximum protection of shellfish growing areas from sewage treatment plant effluents.

5. A performance standard should be established based upon amount of precipitation to prevent the harvest of shellfish containing cattle fecal material carried into the estuary during runoff. This would also help protect against the danger from contamination by improperly treated sewage treatment plant effluents caused by excessive infiltration resulting in overloaded or bypassed treatment units, reduced detention times, and reduced treatment efficiency. The precipitation performance standard would also provide protection from malfunctioning individual waste treatment systems in unsewered areas. Seasons of the year and stream flows, can also be considered in the establishment of performance standards to predict excessive runoff.

6. The classification, performance standards, notification, and operational procedures must be re-evaluated frequently because of the pollution potentials affecting the shellfishing area. This is necessary because the two distinct types of pollution sources, the number of waste treatment plants the growing area, the short travel times of effluents to the growing area, and the relatively small amount of dilution water available in Tillamook Bay combine to make a potentially dangerous situation unless Tillamook Bay is classified and managed properly.

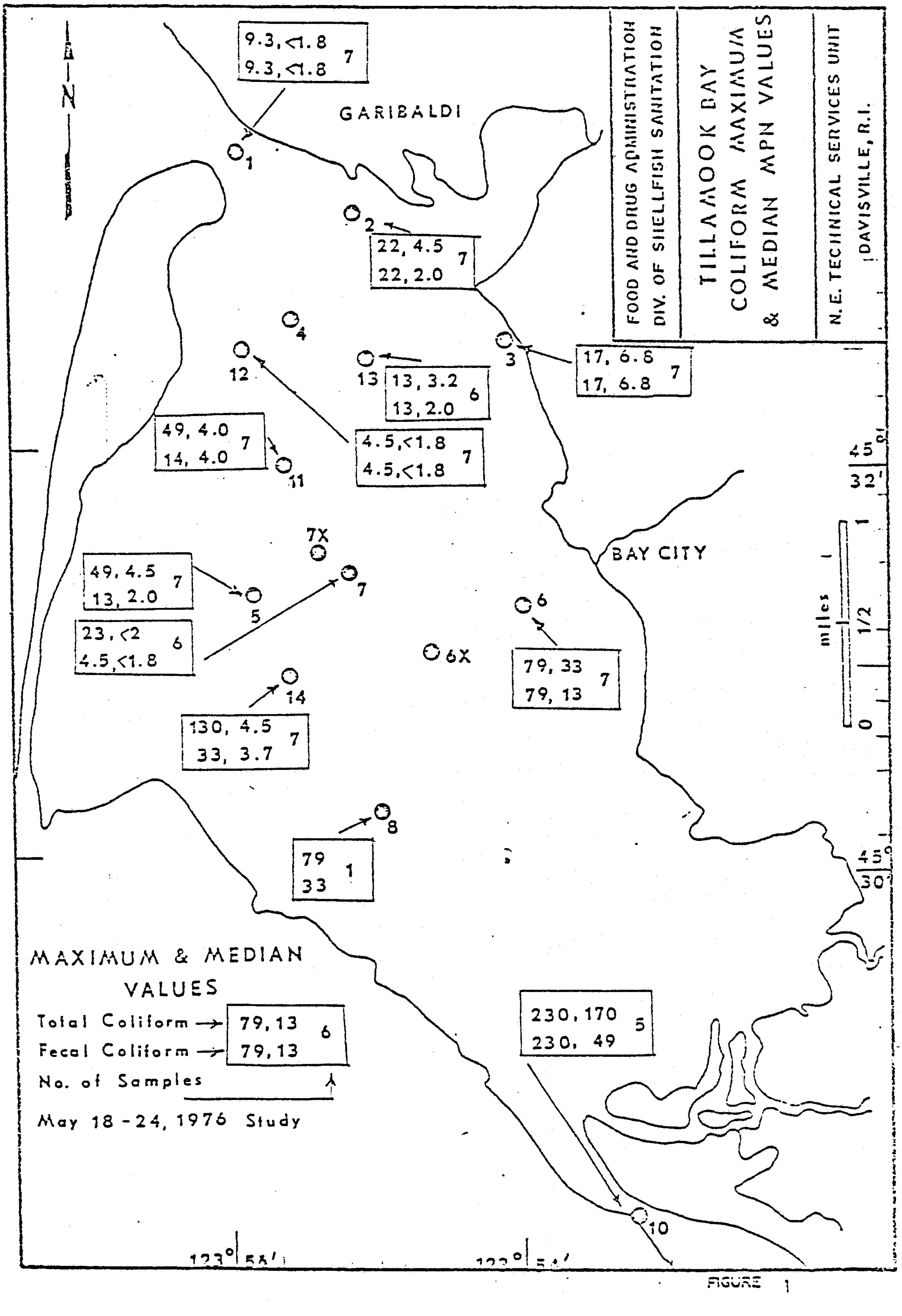
TILLAMOOK BAY, OREGON

SUMMARY AND CONCLUSIONS FROM THE MAY 18-24, 1976, STUDY

1. The study was performed during a period of dry weather with reduced stream flows and low sewage flows at the waste treatment plants. At Bay City, the recorded rainfalls from May 1-22 were 0.44-inch on May 11; 0.31-inch on May 17; and 0.09-inch on May 20, 1976.
2. The water quality of the lower part of the estuary was good during the study. Excluding Stations 6, 8, and 10, the highest total and fecal coliform medians were 6.8 MPN/100 ml at Station 3, and the highest total and fecal coliform values were 130 and 33 MPN/100 ml, respectively, at Station 14. Stations 6, 8, and 10, in the upper part of the bay were more influenced by fresh water flows with resulting higher median values.
3. The tributaries and sloughs were a constant source of fecal pollution into Tillamook Bay. The largest contributors were the Tillamook River, Hoquarten Slough, and Dougherty Slough. Total coliform medians were 1,300; 1,300 and 920, respectively, while the fecal coliform medians were 1,300, 360, and 570, respectively. The _E. coli_ medians were the same as the fecal coliform medians, further establishing that the coliforms are of fecal origin. These streams and sloughs were all in the upper end of the estuary.
4. All oyster samples were of good bacteriological quality during the study. From a total of 23 oyster samples, the highest total and fecal coliform values found were 490 and 230 MPN/100 grams,

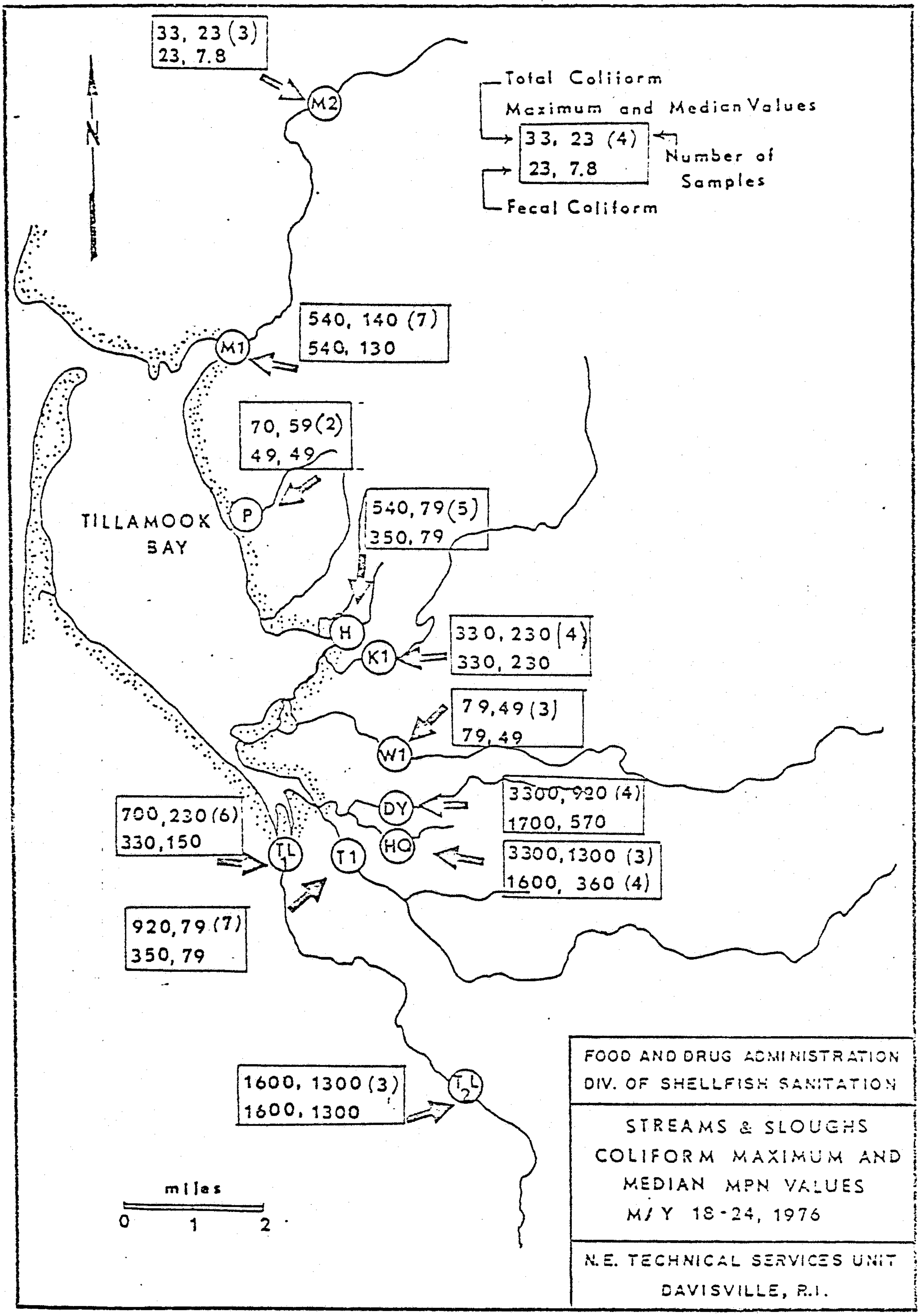
respectively. The highest standard plate count value was 1,800 microorganisms/gram. All fecal coliforms were E. coli indicating low level fecal contamination. No Salmonella were isolated from the oyster samples.

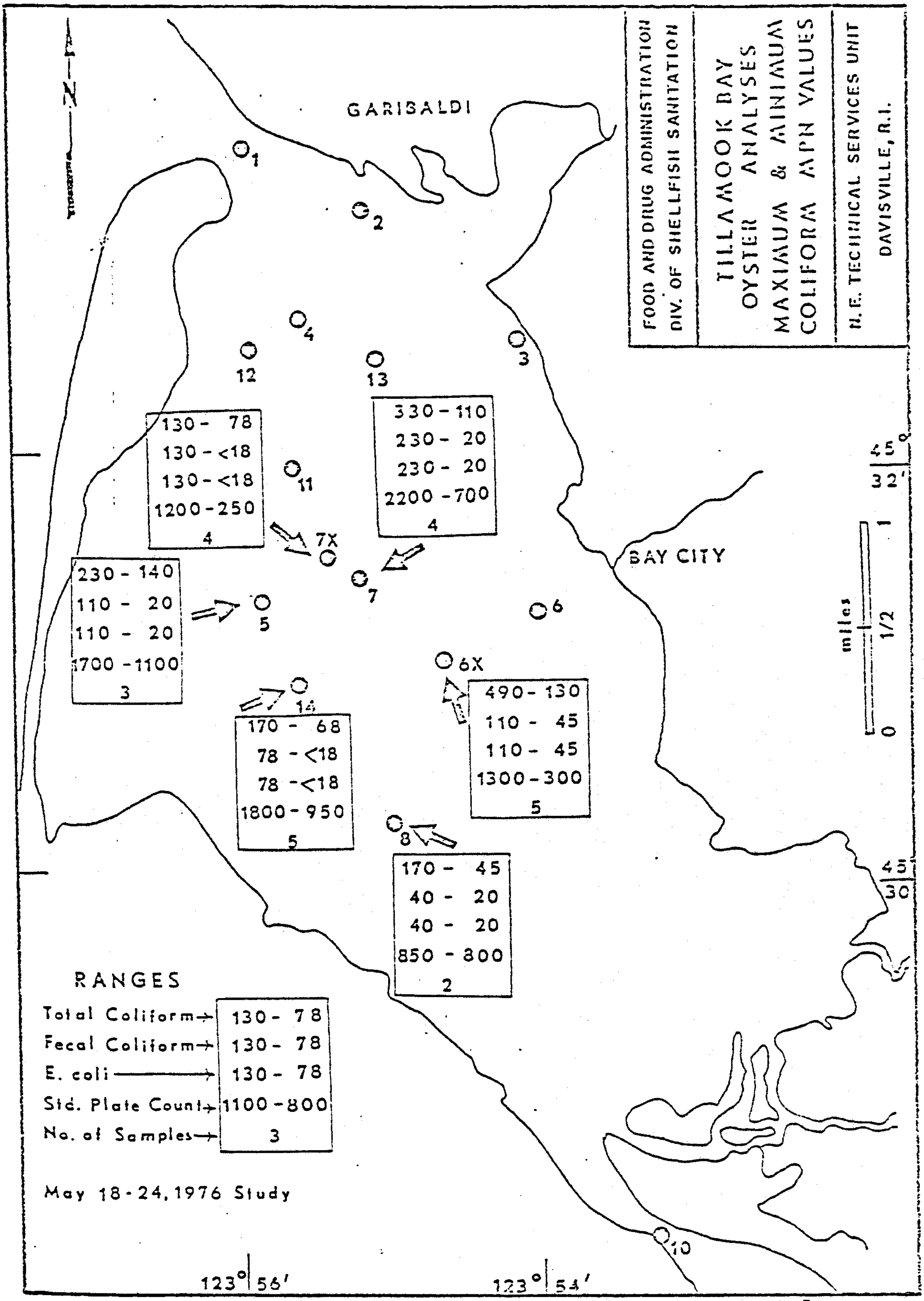
5. No appreciable number of coliforms were found in the surface sediments from samples taken in Tillamook Bay. From a total of 16 sediment samples, the highest total and fecal coliform values were 450 coliforms/100 grams. All fecal coliforms, however, were E. coli indicating the coliforms present were of fecal origin. No Salmonella were found in the sediments.
6. Salmonella was not prevalent in the estuary, tributaries, or sloughs. From a total of 18 Salmonella water samples, Salmonella was presumptively isolated once at Station 14.
7. The five sewage treatment plants were operating well through the first 4 days of the study period and presumed to be operating well until the finish of the study. The chlorine residuals of the effluents varied from 0.5 to 6.0, the maximum total and fecal coliform values found in the effluents were 230 and 23 MPN/100 ml, respectively. The sewage flows were low for all the plants, which was very conducive to good operation.
8. The sewage treatment plants are not designed for the continual protection of shellfish growing waters. There are no continuous effluent quality monitoring systems, no alarms to warn of effluent quality deterioration and no performance standards necessary for utilization of the conditionally approved growing area concept.



FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
COLIFORM MAXIMUM
& MEDIAN MPN VALUES
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
N
GARIBALDI
BAY CITY
9.3, <1.8
9.3, <1.8
7
22, 4.5
22, 2.0
7
17, 6.8
17, 6.8
7
13, 3.2
13, 2.0
6
49, 4.0
14, 4.0
7
4.5, <1.8
4.5, <1.8
7
49, 4.5
13, 2.0
7
23, <2
4.5, <1.8
6
79, 33
79, 13
7
130, 4.5
33, 3.7
7
79
33
1
230, 170
230, 49
5
1
2
3
4
5
6
6X
7
7X
8
10
11
12
13
14
45° 32'
45° 30'
miles
0
1/2
1
MAXIMUM & MEDIAN
VALUES
Total Coliform → 79, 13
Fecal Coliform → 79, 13
6
No. of Samples
May 18 - 24, 1976 Study

FIGURE 1


33, 23 (3)
23, 7.8
M2
N
Total Coliform
Maximum and Median Values
33, 23 (4)
23, 7.8
Number of Samples
Fecal Coliform
540, 140 (7)
540, 130
M1
70, 59(2)
49, 49
P
TILLAMOOK BAY
540, 79(5)
350, 79
H
330, 230 (4)
330, 230
K1
79,49 (3)
79,49
W1
3300, 920 (4)
1700, 570
DY
HQ
3300,1300 (3)
1600, 360 (4)
700,230(6)
330,150
TL 1
T1
920,79 (7)
350, 79
1600, 1300 (3)
1600, 1300
TL 2
miles
0
1
2
FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
STREAMS & SLOUGHS
COLIFORM MAXIMUM AND
MEDIAN MPN VALUES
MAY 18-24, 1976
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.


FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
OYSTER ANALYSES
MAXIMUM & MINIMUM
COLIFORM MPN VALUES
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
N
GARIBALDI
BAY CITY
1
2
3
4
5
6
6X
7
7X
8
10
11
12
13
14
130 - 78
130 - <18
130 - <18
1200 - 250
4
330 - 110
230 - 20
230 - 20
2200 - 700
4
230 - 140
110 - 20
110 - 20
1700 - 1100
3
170 - 68
78 - <18
78 - <18
1800 - 950
5
490 - 130
110 - 45
110 - 45
1300 - 300
5
170 - 45
40 - 20
40 - 20
850 - 800
2
RANGES
Total Coliform → 130 - 78
Fecal Coliform → 130 - 78
E. coli → 130 - 78
Std. Plate Count → 1100 - 800
No. of Samples → 3
May 18-24, 1976 Study
miles
0
1/2
1
45° 32'
45° 30'
123° 56'
123° 54'

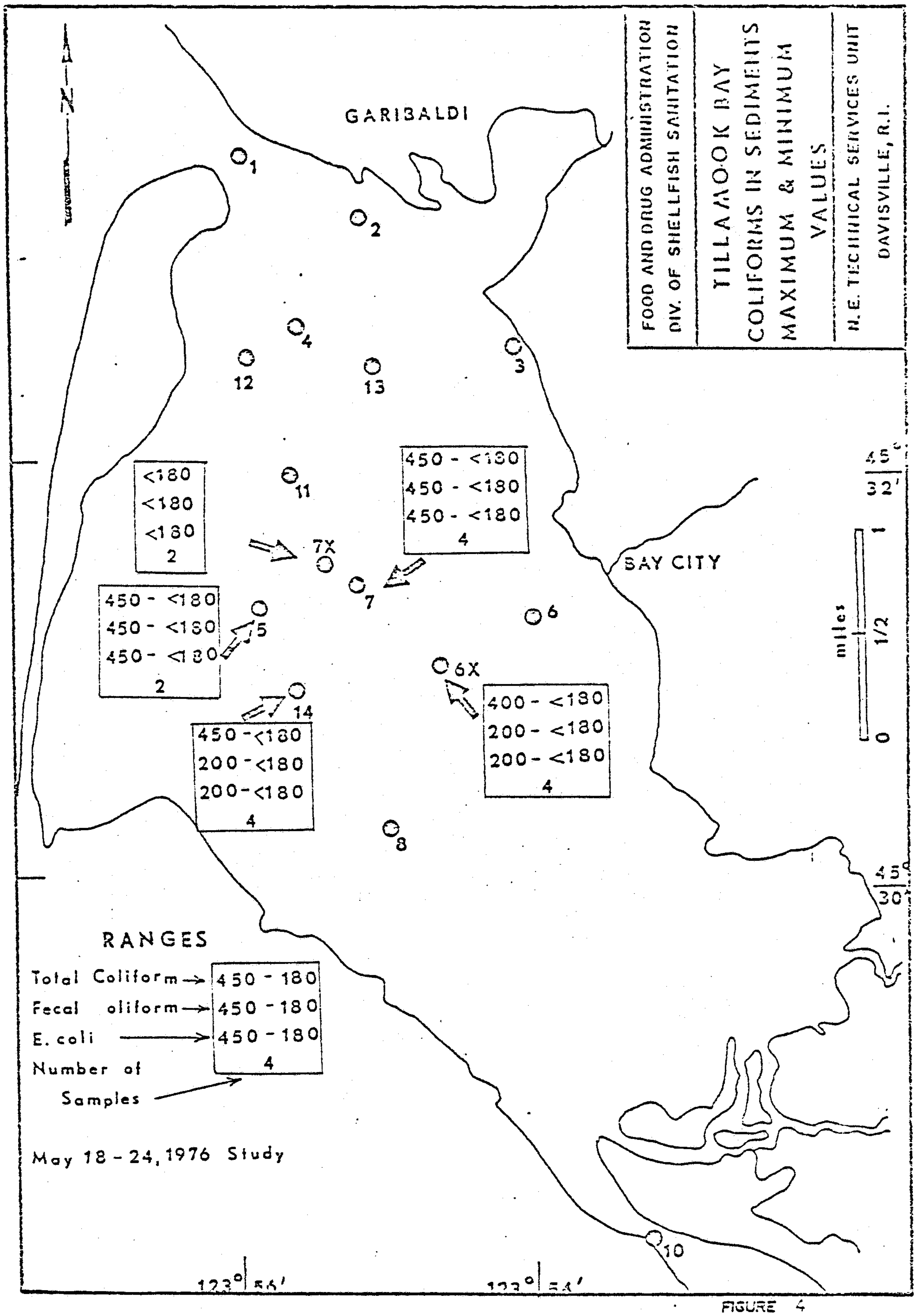

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
COLIFORMS IN SEDIMENTS
MAXIMUM & MINIMUM
VALUES
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
N
GARIBALDI
BAY CITY
1
2
3
4
12
13
11
7X
7
6
5
6X
14
8
10
<180
<180
<180
2
450 - <180
450 - <180
450 - <180
4
450 - <180
450 - <180
450 - <180
2
450 - <180
200 - <180
200 - <180
4
400 - <180
200 - <180
200 - <180
4
RANGES
Total Coliform → 450 - 180
Fecal oliform → 450 - 180
E. coli → 450 - 180
Number of Samples → 4
May 18 - 24, 1976 Study
miles
0
1/2
1
45° 32'
45° 30'
123° 56'
123° 54'

FIGURE 4

APPENDIX O.

Food and Drug Administration, 1977. Tillamook Bay, Oregon Sanitary Survey of Shellfish Waters, Nov.-Dec., 1977. Northeast Technical Services Unit, Davisville, Rhode Island.

Executive Summary

A sanitary survey was conducted of Tillamook Bay's oyster growing and harvesting waters from November 30 to December 13, 1977. The purpose of the study was to determine if the oyster waters are polluted during wet (heavy rainfall and runoff) conditions.

The most important findings were:

1. Flooded septic tanks and leaching fields polluted nearby streams that are tributaries to Tillamook Bay.
2. Dairy cattle and other farm animals contributed fecal waste to stream runoff which subsequently flows to Tillamook Bay.
3. Four of five waste treatment facilities evaluated did not provide adequate treatment of sewage to protect shellfish waters.
4. Bacteriological quality of Tillamook Bay oyster waters exceeded the National Shellfish Sanitation Program (NSSP) recommended total coliform and fecal standards for harvesting shellfish.
5. Tillamook Bay was open to commercial shellfish harvesting during the period of the survey.
6. Forty-four oyster samples from Tillamook Bay were bacteriologically examined. Twenty-eight were found to exceed the NSSP recommended wholesale market quality standard for fecal coliforms.
7. Tillamook Bay Watershed experiences frequent rainfall in the fall and spring which result in fecal pollution of the oyster waters.

Studies conducted in 1974 and 1976 indicated the same potential sources of fecal pollution to Tillamook Bay oyster waters. Results of this survey and the previous two surveys lead to the same conclusion. During wet weather Tillamook Bay oyster waters are polluted with fecal waste. Oysters harvested from Tillamook Bay under wet weather conditions present an unacceptable potential health hazard to the consumer.

Summary

All of the STP's lack the fundamental public health protection items required of the latest EPA design guidelines-i.e. Technical Bulletins: EPA 430/9-74-010, Protection of Shellfish Waters; and EPA 430-99-74-001, Design Criteria for Mechnical Electric, and Fluid System and Component Reliability.

Table 21 provides a summary list of reliability factors which must be taken into account in determining if an STP can protect shellfish waters. As can be seen none of the plants contain all of the desirable features which give confidence regarding public health protection.

The reasons for this involves the lack of the necessary monitoring equipment, plant attendance, alarms, auxiliary power, plant treatment capacity, holding capacity, and redundancy of unit operations.

There are no assurances that any of the municipal STP's can continually protect shellfish waters. There are no assurances that if failures occur they will be discovered. If failures are discovered sufficient time will not be available to prevent harvesting.

TILLAMOOK BAY, OREGON
TEMPERATURE AND RAINFALL DATA*
November 1 - December 15, 1977

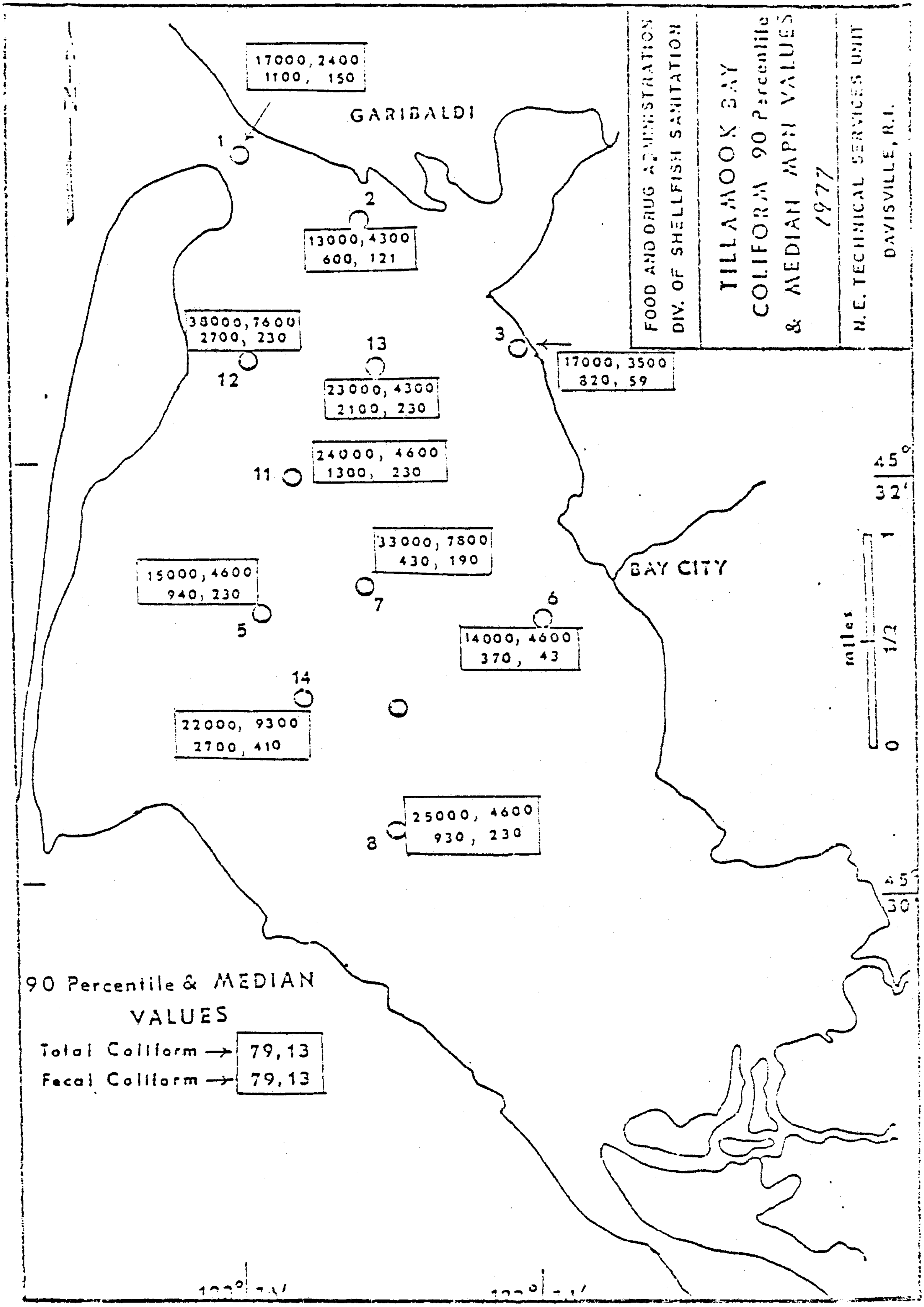
DATE 1977	TEMPERATURE (°F) MAX	MIN	4:00 p.m.	PRECIP. (INCHES)**	DATE 1977	TEMPERATURE (°F) MAX	MIN	4:00 p.m.	PRECIP. (INCHES)**
Nov					Dec				
1	56	45	56	0.92	1	53	44	53	0.58
2	56	39	46	0.76	2	55	53	55	4.92***
3	51	29	50	.05	3	55	47	48	.35
4	50	32	49	.15	4	51	42	46	.20
5	58	44	51		5	48	37	47	T
6	51	36	49	.15	6	53	45	48	.92
7	52	39	45	.50	7	48	38	38	.47
8	52	28	46	.02	8	44	33	40	.25
9	53	42	52	.07	9	44	33	44	.07
10	66	50	55	.93	10	57	43	56	.45
11	59	41	49	.23	11	56	47	53	.74
12	55	40	50	.33	12	53	46	46	.37
13	53	39	52	.70	13	58	50	56	3.98***
14	54	48	50	1.49	14	56	52	52	1.35
15	55	45	52	.58	15	52	43	44	2.19
16	51	43	48	.27					
17	48	31	40	.23					
18	41	30	39	.35					
19	40	22	37	T					
20	41	21	35	0					
21	39	30	37	T					
22	39	31	37	.30					
23	46	35	46	.85					
24	57	44	48	.75					
25	59	44	57	3.44					
26	54	46	50	.05					
27	57	47	50	.35					
28	52	47	51	.06					
29	55	47	50	1.04					
30	50	35	49	.02					

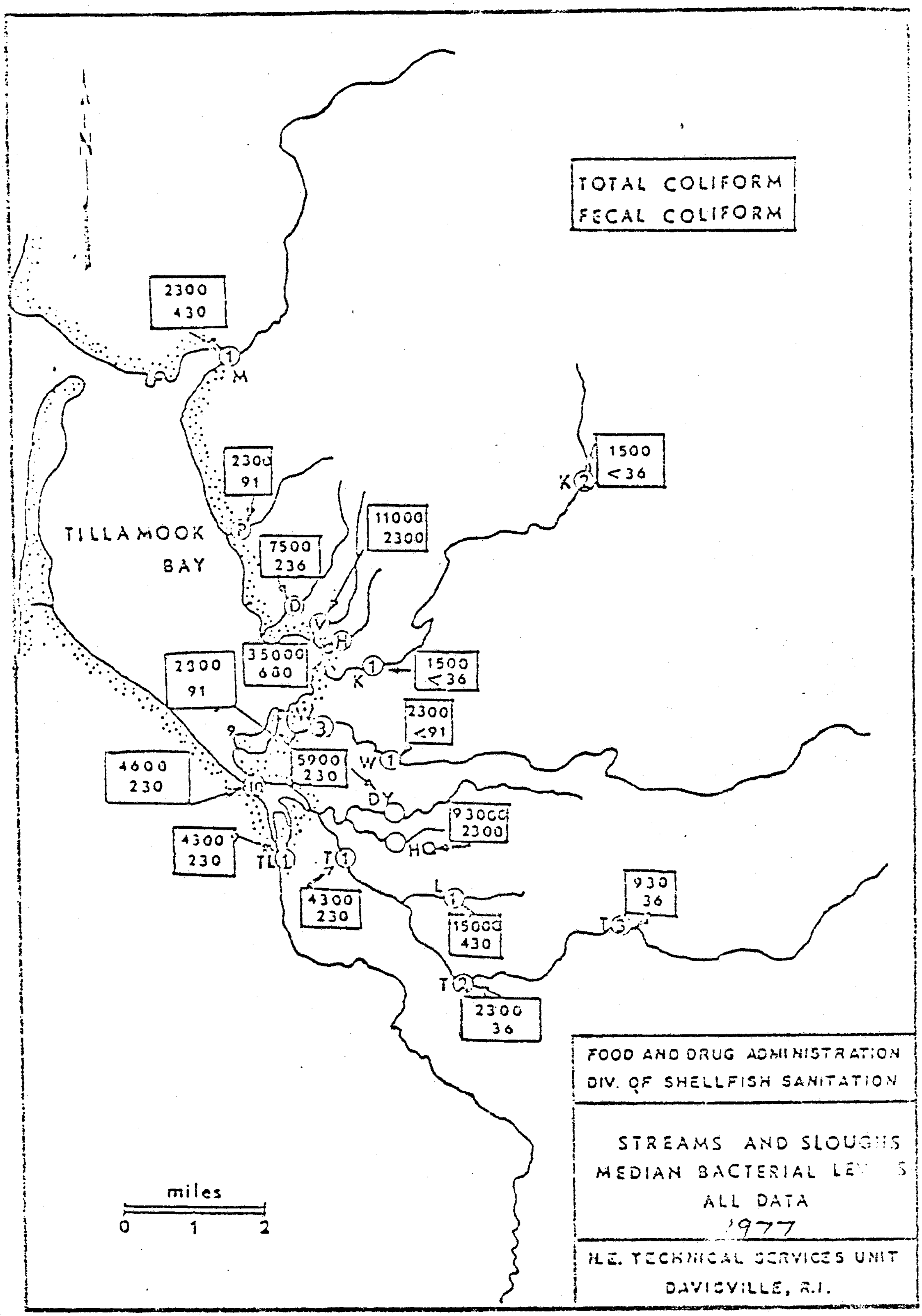
*From: KTIL Radio Station
Tillamook, Oregon

** Precipitation Readings taken at 4:00 p.m.

*** Historical Comparison:

Year	Month	MAXIMUM AMOUNT FOR 1 day	2 days	3 days	4 days	5 days
1971	Jan	4.25	5.95	7.99	9.94	10.52
1972	Jan	4.20	4.70	5.29	6.13	6.61
1975	Nov	4.26	7.36	7.91	9.91	12.00
1977	Dec 1	4.92	5.48	5.83	6.56	6.91
1977	Dec 12	3.98	5.33	7.52	7.89	8.63

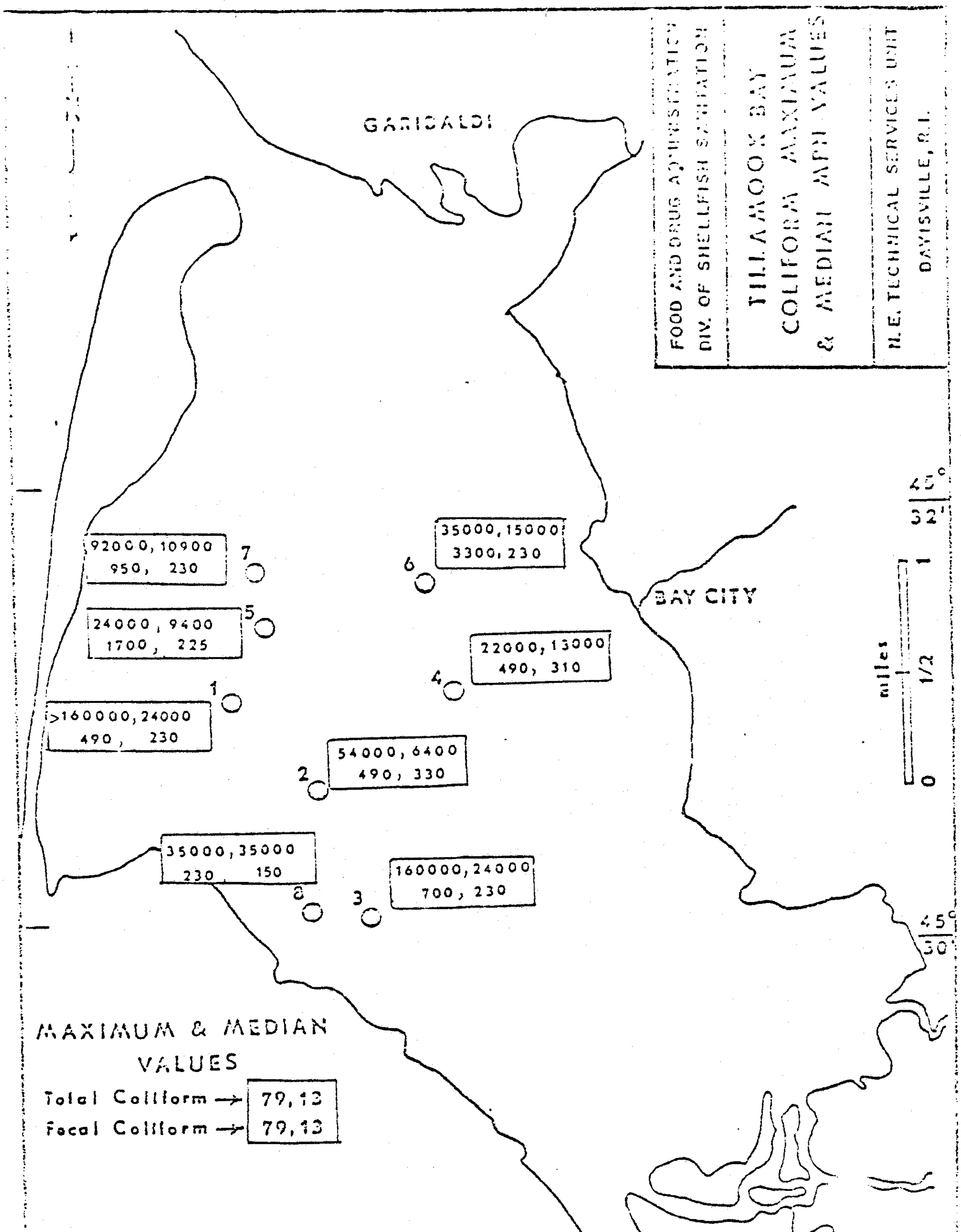

FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
COLIFORM 90 Percentile
& MEDIAN MPN VALUES
1977
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
1
17000, 2400
1100, 150
2
13000, 4300
600, 121
3
17000, 3500
820, 59
12
38000, 7600
2700, 230
13
23000, 4300
2100, 230
11
24000, 4600
1300, 230
7
33000, 7800
430, 190
5
15000, 4600
940, 230
6
14000, 4600
370, 43
14
22000, 9300
2700, 410
8
25000, 4600
930, 230
45° 32'
45° 30'
miles
0
1/2
1
90 Percentile & MEDIAN VALUES
Total Coliform → 79, 13
Fecal Coliform → 79, 13


TOTAL COLIFORM
FECAL COLIFORM
TILLAMOOK BAY
2300
430
M
2300
91
7500
236
11000
2300
1500
<36
K
35000
680
2300
91
1500
<36
2300
<91
9
W
4600
230
5900
230
DY
93000
2300
HO
4300
230
TL
T
4300
230
L
15000
430
930
36
T
2300
36
FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
STREAMS AND SLOUGHS
MEDIAN BACTERIAL LE S
ALL DATA
1977
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
miles
0
1
2

TILLAMOOK BAY, OREGON - 1977

OYSTER COLIFORM SUMMARY

OYSTER STATION	NUMBER SAMPLES	TOTAL COLIFORM MPN/100ml			FECAL COLIFORM MPN/100ml			NO. >230	NO. = 230	NUMBER SAMPLES	E. Coli MPN/100ml		
		MAXIMUM	MINIMUM	MEDIAN	MAX	MIN	MED				MAX	MIN	MED
1	6	>160,000	1,800	24,000	490	45	230	2	2	5	490	130	230
2	6	54,000	2,300	6,400	490	78	330	3	0	5	240	78	130
3	5	160,000	7,900	24,000	700	230	230	2	3	4	280	93	190
4	5	22,000	7,000	13,000	490	45	310	3	0	4	490	45	160
5	8	24,000	1,300	9,400	1,700	78	225	3	1	7	330	45	130
6	6	35,000	310	15,000	3,300	230	230	2	4	6	350	230	230
7	4	92,000	1,300	10,900	950	45	230	2	0	4	950	45	230
8	4	35,000	24,000	35,000	230	130	150	0	1	4	230	78	120
Finished Product Sample	4	>160,000	4,300	24,000	330	45	180	1	1	4	330	45	180



FOOD AND DRUG ADMINISTRATION
DIV. OF SHELLFISH SANITATION
TILLAMOOK BAY
COLIFORM MAXIMUM
& MEDIAN MPN VALUES
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
GARIBALDI
BAY CITY
7
92000, 10900
950, 230
5
24000, 9400
1700, 225
1
>160000, 24000
490, 230
6
35000, 15000
3300, 230
4
22000, 13000
490, 310
2
54000, 6400
490, 330
8
35000, 35000
230, 150
3
160000, 24000
700, 230
miles
0
1/2
1
45° 32'
45° 30'
MAXIMUM & MEDIAN VALUES
Total Coliform → 79, 13
Fecal Coliform → 79, 13

APPENDIX P.

State of Oregon, 1978. Oregon Shellfish Sanitation Task Force, 1978, Report and Recommendations. Oregon State Health Division, Portland, Oregon.

RECOMMENDATIONS

1. Oregon Health Division (OHD), appoint a full time shellfish sanitation specialist whose overall duties will be to: assume primary responsibility for Oregon's shellfish sanitation program; serve as the coordinator of other state agencies and parties involved in the shellfish sanitation program; conduct inspection of shellfish processing establishments; enforce regulatory requirements; and supervise required licensing.

   Comments

   A full-time coordinator responsible for the shellfish sanitation program is essential in the multi-agency endeavor such as this.

   Task force recommendations call for an instant response in case of an emergency, such as a sewage treatment plant failure or a high level of paralitic shellfish poisoning. Only a single responsible agency can react in time to provide effective public health protection.

2. The DEQ must speed up its recommended improvements of coastal sewage treatment plants (STP) to comply with the U. S. Environmental Protection Agency (EPA) performance standard. A guideline of dates for completion of needed facilities upgrading should be set.

   Comments

   Upon the request of the task force, DEQ completed a survey of coastal sewage treatment plants and made recommendations for improvement. There was, however, no implementation date mandated (Appendix E).

3. The OSHD must establish criteria for the closure and reopening of each shellfish processing activity and shellfish growing area based on water samples to cope with possible sewage

treatment plant failure, the introduction of toxic materials, or the occurrence of other unacceptable water quality conditions.

Comments

Additional data may be necessary to establish separate and specific closure and reopening criteria for each shellfish growing water. Each bay has unique hydrologic, climatic and bacteriologic characteristics.

4. Upon bay closure DEQ and OSHD will sample bay waters for fecal coliforms and, if indicated, Salmonella organisms. Shellfish meat samples should be concurrently analyzed for the presence and enumeration of fecal coliforms and Salmonella organisms.

Comments

Intensive study will provide information necessary to reassess the criteria for closure and reopening as well as to provide assurance of public health safety. Modification of procedures and gradual reduction in the number of samples, or the intensity of study, may result as the background information accumulates.

5. The OSHD will sample shellfish meat for fecal coliform and Salmonella organisms.

Comments

This recommendation is a departure from the traditional shellfish sanitation program that relies solely on the bacterial quality of the growing water. While the task force is not minimizing the importance of growing water quality, it feels the immediate risk to public health can be better determined by frequent and regular pathogen sampling of the product itself. Hepatitis A and enterovirus monitoring would be ideal but these cannot be enumerated by the techniques and resources presently available.

The presence of Salmonella organism must be determined, even though the isolation and enumeration procedures are more involved than those for fecal coliforms. Its presence in shellfish meat signals an imminent public health risk, requiring immediate remedial action.

Fecal coliforms determination, along with Salmonella detection, is recommended in order to establish a practical correlation between the two. In time, however, one of the target micro-organisms may be eliminated or replaced, as the experience warrants.

The task force also favors, at least during the initial stages of this program, greater sample numbers to increase accuracy (see Appendix H for recommendation on microbiological test procedures).

6. The OSHD will establish criteria for the closure and reopening of shellfish processing activity, based on the microbiological levels of the meat samples.

Comments

Since public health hazards from contaminated shellfish are to be determined through meat sampling for pathogens and indicator bacteria, the task force favors graduated remedial response according to the risk categories.

For example, the detection of Salmonella calls for an immediate halt to processing followed by a multiple sampling at the plant. If 5 subsequent samples fail to yield Salmonella, the plant production should be permitted to resume.

In the absence of Salmonella in shellfish meats, fecal coliform levels below 230 MPN will be acceptable. When shellfish meat samples contain no Salmonella but the fecal coliform level is above 230 MPN, 5 meat samples from the same lot of shellfish shall be taken for fecal coliform analysis and, if not more than 2 samples out of 5 contain 230 MPN or more, the product will be deemed acceptable. If more than 2 out of 5 samples yield more than 230 MPN, remedial action shall commence. If the unacceptable condition persists, due to the presence of Salmonella or high fecal coliform level, shellfish processing will be prohibited until one or more of the acceptable conditions have been restored (Appendix F).

7. DEQ will intensify their estuarine monitoring program, concentrating mainly on stations within the shellfish growing area.

Comments

Present level of activity by DEQ is limited to 3 estuarine water sample periods per year. The task force believes at least one sample period per month is needed for growing water management purposes. To offset the increase in the number of samples, the task force recommends an elimination of the total coliform standards and adoption of the fecal coliforms standard. The task force is further willing to eliminate the sampling stations that are not within the approved or conditionally approved shellfish growing area, so that the limited resources will enable a greater number of samples to be taken within the growing water area (Appendix G). In critical estuarine zones the number of sampling stations and the frequency of monitoring may have to be increased as experience may dicate.

8. Maintain the present level of activity in paralytic shellfish poisoning surveillance . Samples are to be taken from five sampling stations. These are located near Tillamook, Newport, Yachats, Coos Bay and Brookings. Samples should be run one time each during April and May and twice a month during June, July, August, September and October.

Comments

Paralytic shellfish poisoning results from the infrequent occurrence of a specific marine dinoflagellate that may be ingested by shellfish.

The presence of PSP in Oregon coastal waters has been historically low. However, it is frequently high in California and Washington waters. Nevertheless, this important public health surveillance program is indispensable as an integral part of the overall shellfish sanitation program.

9. The DEQ and Oregon Department of Agriculture (ODA) will develop programs for reducing nonpoint source pollutants, such as the surface water pollution from the dairy or livestock industry, through implementation of best management practices.

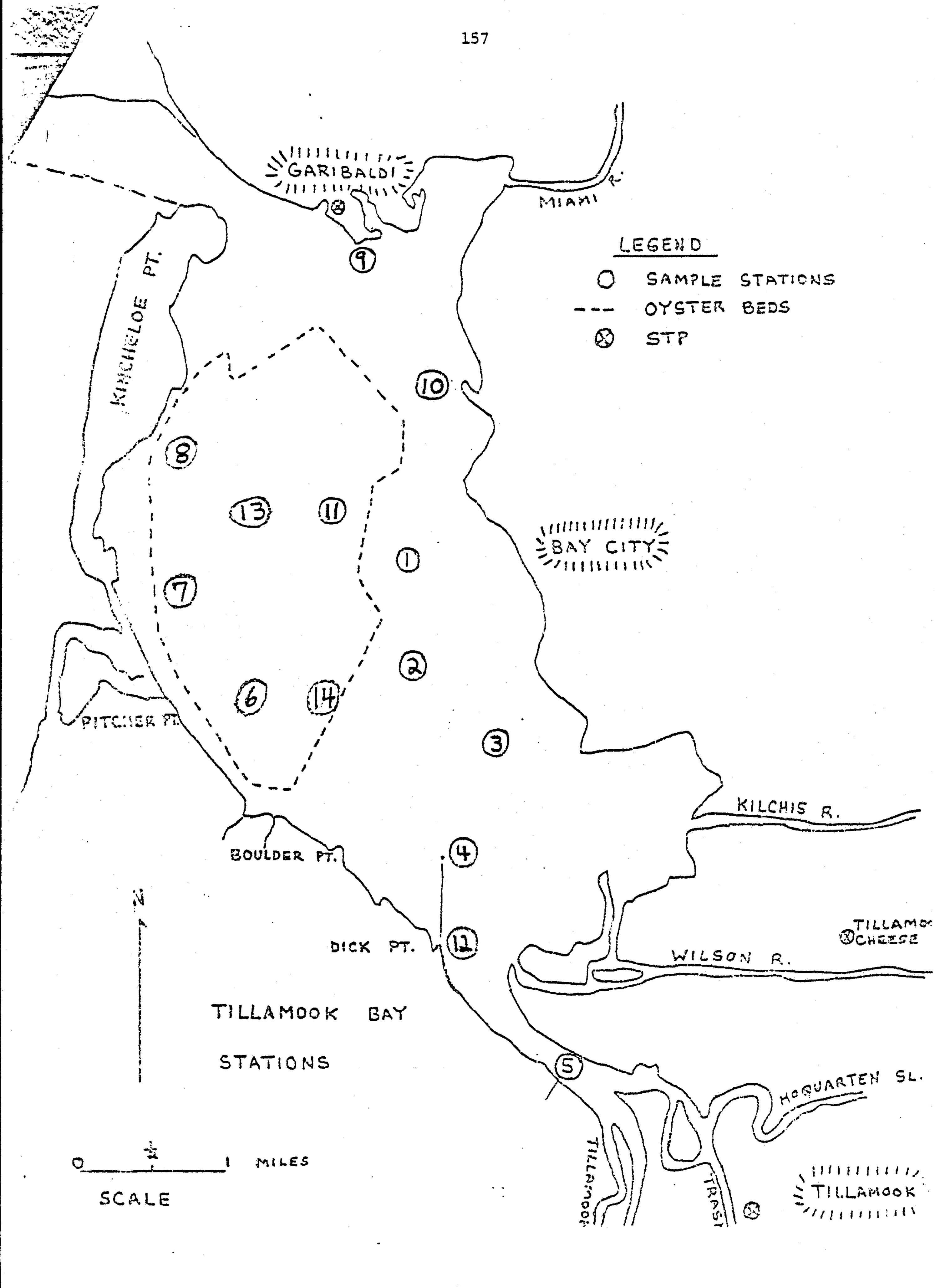
Comments

While the DEQ and ODA now foster and implement certain nonpoint source waste control programs, it is very likely that additional improvement can be made. It is the task force's understanding that added emphasis on this matter should result from the federally financed "208" nonpoint source waste management program now administered in Oregon by the DEQ.

BUDGET

Both the OSHD and DEQ have recently prepared budget requests to fund the up-graded shellfish sanitation program needs as identified in this document.

The State Health Division has developed budgets for the Public Health Laboratory of $72,000, and for the Environmental Health Section of $61,150. DEQ's contribution will be included in their statewide water quality monitoring budget.


GARIBALDI
MIAMI R.
LEGEND
SAMPLE STATIONS
OYSTER BEDS
STP
KINCHELOE PT.
BAY CITY
PITCHER PT.
BOULDER PT.
KILCHIS R.
DICK PT.
TILLAMOOK CHEESE
WILSON R.
TILLAMOOK BAY
STATIONS
HOQUARTEN SL.
0 ½ 1 MILES
SCALE
TILLAMOOK
TRASK
TILLAMOOK
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14

TILLAMOOK BAY

Total Coliform

Station	7/15/75	12/17/75	4/27/76	3/5/77	8/12/77	12/7/77
1	240	460	23	240	-	93
2	1100	43	93	75	460	460
3	1100	43	240	240	36	1100
4	1100	1100	93	240	1100	1100
5	1100	240	-	240	460	1100
6	9	23	23	75	-	1100
7	4	240	4	460	-	290
8	4	43	23	120	43	1100
9	43	150	-	15	3	93
10	7	93	23	43	9	39
11	9	23	-	23	9	1100
12	1100	460	150	460	1100	1100
13	3	460	-	75	9	-
14	43	75	23	23	23	1100
Median T.C./ 100 ml	43	122	23	97	36	1100
Percent exceeding 230 T.C./100 ml	43%	43%	10%	43%	36%	77%

TILLAMOOK BAY

Fecal Coliform

Station	7/15/75	12/17/75	4/27/76	3/5/77	8/12/77	12/7/77
1	43	39	9	43	-	43
2	93	23	15	23	150	93
3	460	43	43	93	23	240
4	240	460	9	240	120	460
5	460	43	-	240	43	75
6	4	23	3	23	-	1100
7	3	240	3	15	-	210
8	3	43	3	23	43	93
9	43	9	-	9	3	9
10	3	4	9	9	9	23
11	3	23	-	9	9	93
12	460	240	43	460	3	460
13	3	21	-	60	3	-
14	3	39	36	9	4	1100
Median F.C./100 ml	24	39	9	23	9	93
Percent exceeding 43 F.C./100 ml	36%	21%	0%	36%	18%	77%

SHELLFISH SANITATION PROGRAM TREATMENT PLANT SURVEY

1. TOLEDO- The Toledo plant discharges treated effluent to the Yaquina River at river mile 13.2 which is about 7 miles above the shellfish growing area in Yaquina Bay. The City has had an active infiltration/inflow (I/I) correction program and a progress report dated June 8, 1978 reported many repairs made plus inspecting, grouting and testing of 5880 feet of line. There are five pumping stations and one portable 30 KW generator to use in case of a total power failure. There has been one reported by-pass within the last year due to equipment failure. There are three visual alarms that warn of high water.

Chlorine is added using dual tanks. They are weighed daily and changed from one tank to the other manually. Chlorine residuals are recorded three times daily. Plant solids are dewatered in beds with the underflow discharging to the plant outfall line without further treatment.

The plant is of the activated sludge type and meets the treatment requirements with respect to BOD and suspended solids removal. Increased reliability could be provided with an auxiliary generator and the City is looking for another 50 KW generator to mount at the plant.

RECOMMENDATIONS:

a. Continue the I/I correction program.
b. Purchase and install a generator for auxiliary power at the plant.
c. Expand the alarm system to every potential point of overflow.
d. Purchase and install an automatic chlorine cylinder changeover device.
e. Remove or re-plumb the sludge bed drains so they do not drain untreated waste into the outfall line.
f. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

g. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

2. GARIBALDI - The Garibaldi plant is of the activated sludge type with effluent polishing by sand filtration. The plant discharges directly to Tillamook Bay. There is not a designated program for I/ correction at this time and it does not appear to be a serious problem. Four pump stations serve the City and two of these are equipped with high water alarms. The two main lift stations are connected to the 85 KW generator located at the plant. There are two chlorinators and multiple chlorine cylinders are used but change over is manual. Solids disposal is on an approved site away from the plant.

RECOMMENDATIONS:

a. Expand the alarm system to every potential point of overflow.
b. Purchase and install an automatic chlorine cylinder changeover device.
c. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.
d. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

3. TILLAMOOK - The Tillamook plant is a trickling filter type plant with effluent discharge to the Trask River. The plant is scheduled for re-construction work that will expand and upgrade the level of treatment. Construction plans were approved in July 1978. A complete sewer system evaluation study was completed by the engineering firm of CH_2M Hill in 1977. Major points of infiltration were identified. Inflow was found to be insignificant. The infiltration correction program that was found to be most cost-effective will eliminate up to 2.09 MGD at a cost of $198,000 and the balance to be treated in the new plant. There are three pumping stations in the system. An auxiliary generator is located at the 12th Street Station. The alarm systems are not presently working and these are scheduled to be repaired during plant construction. Dual units

for process treatment and disinfection will be provided. Solids disposal is scheduled for port property. The construction schedule for the new plant requires completion within 22 months of the Step III grant offer. A schedule is attached.

RECOMMENDATIONS:

a. Complete the infiltration correction program as approved in the Facility Plan.
b. Re-activate the alarm system to warn of possible overflow at every potential overflow point.
c. Purchase and install an automatic chlorine cylinder changeover device.
d. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.
e. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

4. BAY CITY - The Bay City waste treatment facility consists of raw sewage stabilization ponds followed by effluent chlorination and discharge to Tillamook Bay. There is some infiltration in the system and in December of 1977 the lagoon dike over-topped in one location. This has since been built up to prevent a recurrence. There is one pump station equipped with both visual and audible alarms and a generator for auxiliary power. Disinfection is by chlorination and discharge can be controlled by storing in the lagoons. An automatic chlorine cylinder changeover would add further reliability.

RECOMMENDATIONS:

a. Purchase and install an automatic chlorine cylinder changeover device.
b. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.
c. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

5. TILLAMOOK COUNTY CREAMERY - The Tillamook Co. Creamery has an activated sludge plant to treat the sanitary wastes generated at the Creamery. There is one pump station that pumps directly to the plant. There is no overflow at this pump station. An extended power outage or pump failure will cause waste to back up into the service area of the Creamery. A general power failure also means no power at the creamery so no waste would be generated to cause a problem during that time. The activated sludge chamber has been equipped with a sludge blanket alarm that will warn if sludge is rising in the clarifier. Also, an automatic chlorine cylinder changeover device has been installed that will switch chlorine cylinders when one tank becomes empty.

An additional aerobic digester was being installed to provide better digestion and more storage. Digested sludge is applied to farm fields in the area.

RECOMMENDATIONS:

a. Provide written procedures for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.
b. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

6. PORT OF TILLAMOOK BAY - The Port of Tillamook Bay treats waste in stabilization lagoons with the effluent being chlorinated and discharged to the Trask River. The collection system is known to have a number of stub-outs and open drains that contribute to problems of high flow. An irrigation program that would remove effluent from the River had been proposed but land requirements were too high to implement. Instead, a program to test, clean and remove excess flow from the sewer system has been proposed at an estimated cost of $30,385.00. When completed this improvement should result in waste flows that will be within the design capacity of the plant.

There is one pumping station that is equipped with dual pumps, and a visual alarm. There is no standby generator. There were no reported by-passes within the last year.

Disinfection is by chlorination in the plant outfall line. There is only one chlorinator and one chlorine cylinder connected at a time.

RECOMMENDATIONS:

a. Complete the I/I correction program.
b. Purchase or have available a generator to provide standby power at the lift station in case of power failure.
c. Purchase and install an automatic chlorine cylinder changeover device.
d. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.
e. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

7. COOS BAY NO. 1 - The plant is of the activated sludge type. The collection system has some combined sewers that cause winter-time by-passing at the plant. The engineer's estimate for correcting or controlling I/I is $1.4 million. Timing will depend on federal funding and priority of the project.

There are 21 lift stations and all except #12 & #13 have standby power on site, with automatic switch over. Pumping capacity exceeds plant hydraulic capacity and by-passing occurs at the plant.

Disinfection is accomplished with chlorination. Only one cylinder is connected at a time with manual changeover. Solids are either dewatered or disposed of on approved sites in liquid form. Monthly NPDES reports are satisfactory but more detailed procedures are needed for handling emergencies. The alarm system appears adequate.

RECOMMENDATIONS:

a. Complete the sewer system evaluation survey and implement an I/I correction program.

b. Provide stand-by power for pump stations #12 & #13.

c. Purchase and install an automatic chlorine cylinder changeover device.

d. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

e. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

8. COOS BAY NO. 2 - The plant is of the activated sludge type. The sewer collection system is separate and infiltration is not a serious problem. There have been no reported instances of by-passing during the past year. All pumping stations are equipped with on-site standby power. Alarm systems are monitored at the police station.

Some minor modifications are presently proposed for the headworks units and solids handling. Disinfection is accomplished with chlorine. There is only one chlorinator and one cylinder used at a time.

The monthly monitoring reports are complete but detailed instructions with regard to notification in case of emergency are incomplete.

RECOMMENDATIONS:

a. Purchase and install an automatic chlorine cylinder changeover device.

b. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

c. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

9. NORTH BEND - The North Bend plant is of the activated sludge type with effluent discharge to Coos Bay. Approximately 25% of the collection system is combined and infiltration is present in much of the sanitary portion. A sewer system evaluation study (SSES) has been completed and $300,000 for infiltration correction included in the EPA needs survey. An additional $1.5 million will be needed for

combined sewer overflow correction. Completion of this work will depend on the availability of funding through EPA.

There are nine pumping stations, four of which have auxiliary standby generators. They do not have automatic switching gear. By-passing occurs three to four times per month in winter. Completion of the I/I work should eliminate the excess flow by-passing. Installation of standby power at the other five pumping stations should control equipment or power failure by-passing.

Disinfection of plant effluent is by chlorination using single ton cylinders. A manifold for dual tanks and automatic changeover is recommended.

The monthly NPDES monitoring reports are satisfactory but specific instructions for notification in case of emergency were lacking. High water alarms need to be wired into the Police Station where 24-hour contact is available.

RECOMMENDATIONS:

a. Complete the SSES and implement the Infiltration/Inflow program as soon as funding is available.
b. Purchase and install auxiliary power equipment for all pump stations not presently equipped.
c. Improve the alarm system so a responsible person can be alerted in case of equipment failure or high water.
d. Purchase and install an automatic chlorine cylinder changeover device.
e. Provide written procedure for notification of all parties that would be affected by the by-pass or overflow of untreated or partially treated waste.
f. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

APPENDIX Q

OREGON STATE
SHELLFISH PROGRAM EVALUATION
1977 - 1978

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INTRODUCTION

The Oregon State shellfish sanitation program in recent years has not complied with the provisions of the NSSP. As a result of our 1976-1977 evaluation and the Oregon State control agencies and industry review, it was determined that it would appropriate to form a task force to examine, in depth, the problems and deal with them. The result of this review is the Oregon Shellfish Sanitation Taskforce 1978 Report and Recommendations.

Since there has been little or no change in program activities, FDA's annual evaluation for the 1977-1978 period was delayed until the publication of the task force document.

It represents the only tangible development which has taken place in the program in the last year. Therefore, each management strategy and recommendation will be discussed in this evaluation report.

RECOMMENDATION 1

Oregon State Health Division appoint full time shellfish sanitation specialist.

Comment: This is essential for a viable program. For a number of years we have been critical of lack of program time available to the individual assigned shellfish responsibilities. There has been an inordinate amount of personnel turnover resulting in a loss of program continuity.

I would also recomend that since we are dealing with interagency relationships that each of the agencies involved identify a key individual to deal with the OSHD individual.

RECOMMENDATION 2

The DEQ must speed up its recommended improvements of coast sewage treatment plants to comply with the EPA performance standard.

Comment: I would concur with the thrust of this recommendatiton. I reviewed the recently completed survey by DEQ and their recommendations. However, I found those recommendations to fall short of the managment strategy stated on page 5, "Upgrade the facilities and operational practices of coastal sewage treatment plants (STP) to meet the Environmental Protection Agency (EPA) performance standards for protection of shellfish growing waters, as identified in EPA Technical Bulletin 430-99-74-001."

Tillamook City Sewage Treatment Plant

DEQ Recommendations:

a. Complete the infiltration correction program as approved in the Facility Plan.

b. Re-activate the alarm system to warn of possible overflow at every potential overflow point.

c. Purchase and install an automatic chlorine cylinder changeover device.

d. Provide written procedure for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

e. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

Comment: The above recommendations are good, however, we have made two other recommendations in the past that we still feel are viable.

Our November 1977 assessment of the proposed plant modifications was that even with the infiltration correction work the primary settling tanks would still be overloaded periodically.

However, even more significant there was no provision for improving the chlorination system present in the CH_2 MHILL Engineering Report. As noted above DEQ is now planning on upgrading the alarm system and requiring an automatic changeover device on the chlorine tanks. We view these improvements as important. However, the plant still fails to meet EPA design criteria for a plant discharging into shellfish waters. This plant should meet the criteria outlined for a Class I reliability plant as set forth in EPA Technical Bulletin 430-99-74-001.

Without some means to assure adequate disinfection of the effluent with appropriate alarms when there is low chlorine levels, the quality of the effuent will still remain questionable. Adequate disinfection would be effective premixing and a minimum of 30 minutes contact time at peak hourly flow with a residual chlorine level that can be detected with an appropriate automatic chlorine analyzer.

However, it should be pointed out that there was poor correlation between chlorine residuals and bacterial kill emphasizing the adequate contact time is of primary importance with the residual analyzer acting as a check.

In addition there should be performance standards for the STP established that will spell out to everyone concerned the minimum operating conditions that must exist for the shellfish area to remain open. Of paramount concern should be whether there is effective disinfection of the effluent. If there is doubt, then the health authorities should be immediately contacted so harvesting can be suspended.

Bay City Sewage Treatment Facility

DEQ Recommendations:

1. Purchase and install an automatic chlorine cylinder changeover device.

2. Provide written procedure for notificaiton of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

c. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

Comment: During our November 1977 study this plant was forced to discharge continually, rather than following original design plan to discharge only on ebbing tides. The problem had been caused by a breakdown in the only chlorinator. This underscores the recommendation that for reliability a second chlorinator should be installed. Under normal conditions the contact time should be sufficient.

However, at the high discharge rates the detention times are well under the minimum 30 minute contact time. (This should be considered a plant failure and the shellfish harvesting suspended.)

The plant should be equipped with a chlorine residual analyzer-recorder with associated alarm systems for low residuals. This is recommended in spite of the fact that this facility currently has a pressure switch which shuts off the effluent pumps in the case of low chlorine feed pressure. It is our feeling that present automoatic switch detects only the most serious problem without providing monitoring of an actual chlorine residual after treatment.

Serious consideration should be given to a more accurate system of recording abnormal flows. For instance during our 1977 survey the actual amount beng discharged was twice as much as the figure routinely calculated on a pump run time-discharge basis and placed on the plant records.

Garibaldi Sewage Treatment Plant

DEQ Recommenations:

a. Expand the alarm system to every potential point of overflow.

b. Purchase and install an automatic chlorine cylinder changeover device.

c. Provide written procedure for notificaiton of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

d. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

Comment: We support these recommendations. Our November, 1977 study concluded that there were at least three treatment failures during the study relating to drops in chlorine residuals. Premixing and contact detention time appears sufficient. Therefore we would only recommend in addition to the above items that a residual chlorine analyser-recorder with appropriate alarm be installed.

Tillamook Creamery

DEQ Recommendations:

a. Provide written procedures for notification of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

b. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

Comment: It appears the proper functioning of the additional aerobic digester will be critical to the proper functioning of this plant. Additional consideration should also be given to installation of a chlorine residual analyzer-recorder after the digester is on line.

Port of Tillmook

DEQ made five recommendations, some which are currently being acted upon. For the time being these appear to be adequate.

DEQ Recommendations:

a. Complete the infiltration/inflow correction program.

b. Purchase or have available a generator to provide standby power at the lift station in case of power failure.

c. Purchase and install an automatic chlorine cylinder changeover device.

d. Provide written procedure for notificaiton of all parties that would be affected by the by-passing or overflow of untreated or partially treated waste.

e. Maintain a log of all by-passes and notifications and report all such occurrences on the monthly NPDES monitoring report.

Task Force Recommendation #3

"The OSHD must establish criteria for the closure and reopening of each shellfish processing activity and shellfish growing area based on water samples to cope with possible sewage treatment plant failure, the introduction of toxic materials, or the occurrence of other unacceptable water quality conditons."

Comment: We concur with the intent of this recommendation. We have previously stressed the importance of establishing a performance standard for the STP plants. This concept should be extended to the total growing area. However, the criteria that is established should not be counter to the regulations of Oregon State Health Division or the provisions of the NSSP.

Task Force Recommendations #4 and #5

"Upon bay closure DEQ and OSHD will sample bay waters for fecal coliforms and, if indicated, salmonella organisms. Shellfish meat samples should be concurrently analyzed for the presence and enumeration of fecal coliforms and salmonella organisms."

"The OSHD will sample shellfish meat for fecal coliform and salmonella organisms."

Comment: We have no objection to more definitive analysis than the routine total and fecal coliform enumeration. We have in fact, where resources were available, analyzed for salmonella, vibrio, fecal streptococcus, and viruses. However, we have not been convinced the absence of these pathogens in either the shellfish meats or growing waters constitutes evidence that the waters are safe for direct harvesting and processing. Where the area is known to be subject to fecal wastes and the coliform or fecal coliform levels exceed the approved growing area standards, we feel that the areas should be closed.

The problem of using a pathogenic organism is summarized in the Brezenski and Russomanno paper on "Detection and use of Salmonellae in Studying Polluted Tidal Estuaries" in the May 1969 "Journal of Water Pollution Control Federation".

> "The freedom from pathogenic entities consititutes the ideal criterion for declaring a body of water safe from the disease hazard. Since the inoculation of water by pathogenic microorganisms is accomplished via fecal excrement of man and animals, an array of species of the pathogenic variety can be expected. Brucella, Samonella, Shigella, Mycobacterium (tuberculosis), Vibrio cholera, Entamoeba histolytica, and various enteric viruses may be present in the feces of warm-blooded animals. Normal healthy specimens may contribute organisms via feces while in the carrier state as in the case with the classical salmonella carriers.
>
> Densities of pathogens in the acqueous environment will be affected by several factors: (a) the type and degree of treatment given to waste material prior to discharge; (b) the ability of micro-organisms to survive the effects of antibiosis, predation, and chemical constituents in the water; (c) dietary habits and socio-economic status of the community; (d) the prevalence of specific disease in the community; (e) endemic conditions in the human and animal population; and (f) existent carrier rates in the population. Consequently, the introduction of specific pathogens via fecal excrement into water is not constant, but tends to be intermittent. Intermittent pathogen introduction results in uneven microoganism distribution in water, and the effects of dilution and environment further will influence densities and distribution of pathogenic forms in a given body of water.

To determine complete freedom from all pathogenic entites in water poses an impossible task. Detection systems lack sensitivity, are lengthy, and at best are semi-qualitative in nature. As a result, direct pathogen testing at this time becomes impractical when high frequency sampling and continuous surveillance are required. However, until rapid, sensitive, quantitative procedures for pathogen detection are available, current technology must be relied on to develop pathogen-indicator relationships. Informaton concerning the prevalence in water of certain pathogenic forms with concurrent densities of indicator bacteria is desirable, providing present limitations in pathogen recovery systems are taken into consideration.

The development of more accurate and simplified salmonella techniques, in addition to available information on the prevalence of salmonellae in human and non-human reservoirs, points out the feasibility of this approach to indicate hazardous conditions. However, it must be realized that the absence of salmonella does not reflect or indicate directly the absence of other pathogenic entities."

Task Force Recommendation #6

"The OSHD will establish criteria for the closure and reopening of shellfish processing activity based on microbiological levels of the meat samples."

Comment: We do not agree, in general, with this recommendation, although there is some merit with a portion of the recommendation under certain circumstances. As stated this recommendation attempts to establish a preventative public health program based on shellfish meat samples. The concept of determining suitability of a growing area by analysis of shellfish meats has never been endorsed by public health agencies since the development of the program in 1926. At the same time high levels of fecal coliform in the product should not be ignored.

We have support analysis of both water and shellfish meats after a closure based on water quality and/or a situation of potential contamination. After closure and correction of the pollution source a period of time for the shellfish to cleanse themselves should be allowed. Water and shellfish samples should then be examined to assure that the water quality meets approved criteria and the shellfish have actually been biologically active in eliminating the pollution.

The numerical criteria in conjunction with the salmonella analysis discussed in this same recommendation would not be acceptable.

<u>Task Force Recommendation #7</u>

"DEQ will intensify their estuarine monitoring program, concentrating mainly on stations within the shellfish growing area."

Comment: We do not disagree with any program that gives increased surveillance data. At the same time, everyone involved should recognize the limitation of a surveillance program as opposed to the data obtained through a comprehensive sanitary survey. Data obtained on a one or two day a month sampling can only provide limited informaton on the water quality of those stations at that time. If for instance, high levels are encountered it would indicate that more work should be done to determine if there is a problem. At the same time good results from a number of surveillance samples does not assure that the area is properly classified.

It is also noted that according to the schedule each estuary is not being sampled each month. Therefore, we believe that this recommendation is too conservative in what DEQ and OSHD will need to do as far as sanitary survey work to obtain proper classification of the shellfish growing areas.

<u>Task Force Recommendation #8</u>

"Maintain a present level of activity in paralytic shellfish poisoning surveillance. Samples are to be taken from five sampling stations. These are located near Tillamook, Newport, Yachats, Coos Bay and Brookings. Samples should be run one time each during April and May and twice a month during June, July, August, September, and October."

Comment: We concur with the acknowlegement that this is an important aspect of shellfish control. We believe that the program should be expanded in accord with our previous recommendations. The sampling should be expanded to include samples which correspond more closely to the growing areas including a broader representation of species. For instance, the inclusion of butter clams from the growing area in addition to the mussels, would provide a species that retains the toxin longer than the mussels. This would broaden the base of sampling information.

Task Force Recommendation #9

"The DEQ and Oregon Department of Agriculture (ODA) will develop programs for reducing nonpoint source pollutants, such as the surface water pollution from the dairy or livestock industry through implementation of best management practices".

Comment: We concur with this recommendation fully.

Task Force Recommendation On Shellfish Meat Sampling Schedule

We consider the schedule presented to represent a limited surveillance sampling schedule (six or less samples per processor in a six month period). At best, it will provide limited information on the bacteriological quality of the meats and may alert OSHD if there is a problem. If the data is to be used as a growing area surveillance tool, the samples should be shellstock.

Task Force Recommendation On Microbiological Test Procedures

"1. Membrane filter method for fecal coliform group enumeration.

This procedure, if used with new improved membranes and with modifications to enhance recovery of bacteria, will be ideally suited for routine sea water testing."

Comment: Although the history of Membrane Filters dates back to 1855 in Europe, the method was first applied to the examination of potable water in Germany during World War II. It was included as a tenetative method in the 10th Edition of "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes" in 1955, and was officially adopted as a Standard Procedure in the 11th Edition in 1960. It was accepted as a tentative method for sea water in the 3rd Edition of "Recommended Procedures for the Bacteriological Examination of Sea Water and Shellfish" in 1962 with the understanding that it could be used after adequate parallel testing had demonstrated that it yields, for the particular water in question, equivalent infomation relative to the sanitary quality given by the Multiple-Tube Fermentation Procedure. The bacteriologist was further cautioned that algae, suspended solids, heavy ions, antibacterial substances, a high density of non-coliform organisms, and the inhibitory action of the medium may limit the applicability of this test for sea water.

Presnell, Arcisz, and Kelly, in a study done at Woods Hole, Massachusetts in the early 1950's, reported an agreement of 87.1 percent between the MF and MPN data on sea water samples, and concluded that MF is a reliable method if due regard is given to turbidity and bacterial densities. The MF Method was used extensively in the Raritan Bay Studies of the early Sixties except in the Upper Bay and certain river systems. Considerable work has been done on the MF Proceudre in the Lawrence Experiment Station Laboratory in Lawrence, Massachusetts, by McCarthy, Delaney, and Grasso.

On the basis of comparative MF/MPN data of shellfish growing areas in Massachusetts and Connecticut which have been evaluated by the Northeast Technical Services Unit, MF data is substantially lower than MPN data when used to classify shellfish growing areas on a one-to-one basis. The use of such data would permit marginally-polluted reas to be opened for harvesting of shellfish. Unpublished studies of the Maryland State Health Department showed inconsistent ratios between the MF and MPN data in samples taken from identical stations over varying periods of season and tide. A study is being conducted by the Gulf Coast Technical Services Unit which will provide additional information as to the relative merits of the MF Method for the bacteriological examination of Gulf Coast Estuarine Waters. It is reasonable to assume that the same populations of bacteria are not necessarily being measured by the two methods.

Present National Shellfish Sanitation Program criteria specify the MPN Procedure. If a State Control Agency elects to use the MF Method, that agency is responsible for demonstrating to the Regional Consultant the sanitary significance of the MF data and the relationship of the MF numbers to the MPN Standards for growing areas. These conditions for the use of the MF Method were unanimously stipulated by the 7th National Shellfish Sanitation Workshop upon acceptance of "Recommended Procedures for the Examination of Sea Water an Shellfish, 4th Edition, APHA, 1979," as the official analytical reference of the NSSP.

The Membrane Filter Method has been proven to be an excellent procedure for finished water supplies, but variations in the composition of Estuarine Waters make interpretation of MF data difficult at best.

We recommend that the Modified A-1 procedure be utilized as a rapid method for detection of fecal coliforms.

"2. Rapid method for fecal coliform determinations in shellfish meat.

Presumptive test step may be omitted by incubating LST broth at 44± 0.05°C for 24 hours and streak the gas positive tubes on EMB for confirmation. Combined with 3 tube MPN, this will reduce the laboratory analysis cost by half.

Official 5 tube MPN procedure with LST to EC enrichments should be used for follow up studies."

Comment: This procedure may result in a lower detection rate for fecal coliforms. The opinion has been expressed by some microbiologists that by placing the bacteria directly into the LST broth at 44° ± .5, they are subject to a harsh environment. Some loss of organisms in sea water analysis with this approach was documented in the Andrews and Presnell paper "Rapid Recovery of Escherichia Coli from Estuarine Water, Applied Microbiology, March 1972."

Consideration should be given to using the A-1 modified procedure. This method, although not yet approved for shellfish meats by AOAC, appears to be one that preliminary data looks very good. It would also be less work than the method proposed. In either case if a new method is to be used, some parallel testing should be done with the approved MPN procedures.

"3. Salmonella detection.

Recommended method calls for dual enrichments in tetrathionate (TT) and selenite cystine (SC) broth followed by BG, SS and BS agar differentiations. This presents a combination of 6 enumeration steps. This can be reduced to 2 by limiting the initial enrichment to SC and the growth being streaked on SS agar. The suspect colonies on SS then can be tested on TSI, followed by the polyvalent somatice "O" antigent test, or biochemically differentiated with API20 E system. More elaborate official procedure, however, should be used in any follow up study."

Comment: Short-cutting the presently recommended procedures as proposed may limit the sensitivity of the test. In addition, the proposed use of the selenite cystine as the sole enrichment broth may be questionable. In the paper "Comparative Validity of Members of the Total Coliform and Fecal Coliform Groups for Indicating the Presence of Salmonella in the Eastern Oyster, Crabsostrea Virginica" by W. H. Andrews et al., it was found that tetrathionate broth with added brilliant green followed by streaking on bismuh sulfite agar the most productive.

In general with regard to the proposed screening procedures, we believe that screening techniques should be overly sensitive rather than to lack initial sensitivity with the provision that additional tests can be made later, if needed. In the area of public health we should error on the side having more data than is needed, rather than using abbreviated testing which may not alert us to problems.

APPENDIX R

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