Sulphite Pulp Mill Expansion and Effluent Disposal at Port Alice, V.I.

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Conclusions and Recommendations

1. The present sulphite mill at Port Alice has probably had a considerable influence on the biotic environment in Neroutsos Inlet particularly within one-half mile of the outfall. While there are no data on bottom fauna and fish in the inlet before the mill was established, the conditions observed suggest that the mill effluent may have been responsible for the barren shores.

2. Inasmuch as the salmon runs in Neroutsos Inlet are small (commercial and sport fishing are practically non-existent), it is not likely that the expansion of the Port Alice pulp mill will have any significant effect on the fisheries. Most of the fishing is concentrated to the north of Neroutsos Inlet near Drake Island. Sulphite Waste Liquors, which reach that area in the surface waters, will be dilute and harmless.

3. Conditions in the deep water are unknown at present. It is likely that low dissolved oxygen concentrations are to be found below 50-ft. depth. This is a consequence of the mixing of the effluent into the sea water at the outfall. Such a condition will worsen with the expansion of the mill and the adverse effect on bottom fishes (rock cod, rock bass, flounders etc.) will increase.

4. It is recommended that any modifications in the sewer outfalls include an installation where the effluent will flow over the surface of the inlet water without the intensive mixing occurring at present.

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I Introduction

The sulphite pulp mill at Port Alice is one of the oldest in British Columbia having commenced operation in 1917. It has operated continuously since that time although the management changed from the B.C. Pulp and Paper Company Ltd. to the present Port Alice Division of the Alaska Pine and Cellulose Company Ltd. in 1951. While the original pulp mill was designed for its present maximum production of approximately 220 Air Dry Tons per day, this output was not achieved until 1942. The present production does not fully utilize the water that it receives for its operation and the expansion now underway is designed for more efficient water use. A water volume of about 29,000 U.S. gallons per minute (65 c.f.s.) is piped from Victoria Lake located east of Port Alice. The expansion plans of the mill call for a production increase by 2/3 of the present tonnage or a total of approximately 370 tons. There will be no increase in the water supply to the mill so that it can be expected that effluent discharged will have an increase in concentration of organic materials proportional to the increase in production.

Plans for expansion of the Port Alice mill and discharge of the effluent into Neroutsos Inlet were referred to Mr. A.J. Whitmore, Chief Supervisor of Fisheries, by Mr. Bain of the Alaska Pine and Cellulose Co., Ltd. Some of the basic information on the production of the pulp mill and its effluent disposal has been provided by Inspector G.A. Hooser (1956) of the Department of Fisheries for Area 27. The problem was brought to the attention of the Biological Station in a letter from Mr. Whitmore dated February 22, 1956. The writer visited the mill and observed conditions around the waterfront of Port Alice, June 1, 1956. Some time was spent with Mr. J. W. Fraser, plant superintendent, discussing details of pulp production as they might affect the characteristics of the effluent.

II Production Process

Basically, the sulphite process consists of chemical disintegration of wood-fibres by digestion of wood chips in bisulphite cooking liquor at elevated temperature and pressure. Generally, a calcium bisulphite solution is the liquor although a magnesium base may be used. As in other chemical pulp processes, digestion in chemical solutions is required to render soluble the lignin holding the fibrous material together. Digestion is carried out as a batch process in pressure vessels at a temperature of about 140° C. (284° F.) and pressure in the vicinity of 80 pounds

per square inch. This treatment requires three hours or more and results in the sulphonation of the lignin with the formation of the soluble calcium lignosulphonate. After completion of the digestion, the digestor charge is blown under pressure to blow pits with perforated screen bottoms. Here the spent liquor is separated from the pulp by draining and gravity washing. The drained liquor with the washings is released as a waste and usually passes untreated into natural waters.

After digestion and washing the Port Alice pulp is put through a three-stage bleaching process.

(1) Chlorine water is added to the pulp in the first step. For every pound of chlorine that goes into bleaching the pulp, one pound goes toward solution of the remaining lignin left after the digestion and washings. Very little free chlorine escapes to the sewer. The reacted chlorine enters the sewer as dilute hydrochloric acid. The total chlorine used in this step is about 100 pounds per ton of pulp.

(2) Caustic treatment is the second bleaching procedure to which the pulp is subjected. The pulp is washed with dilute caustic soda. The amount of sodium hydroxide used varies with the grade of pulp; 160 to 180 pounds per ton of pulp seems to be the general range.

(3) Sodium hypochlorite treatment is the final bleaching step. Small amounts of chlorine and caustic soda may be used as well depending on the whiteness of the product at this stage.

There is a possibility of introducing a secondary chlorination stage which would be applied before the sodium hypochlorite treatment. However, this additional step is still only in the experimental stage. It would not contribute additional waste inasmuch as the system will be under a closed recirculation. Free chlorine would be continuously added as its concentration diminishes in the system.

The wood supply used in the present mill consists of 75% hemlock and 25% balsam. It is planned that this proportion of wood will be continued in the mill. To reduce the loss of fibres, screening is being improved. At present, there is a considerable loss in the bark fragments from the hydraulic barkers. The log pond is being rapidly filled with silt.

III Characteristics of Sulphite Waste Liquors

Actual characteristics of the effluent from the Port Alice mill were unobtainable at the time of the writing of this report. However, the average values for other sulphite mills reported in the literature (Water Quality Criteria, 1952, p. 380; Russell, 1956) are reproduced here.

Sulphite Waste Liquor (S.W.L.) is a solution containing 10 to 15% total solids. The content of solids depends on a number of factors including the liquor-to-wood ratio in the digestors, the type of heating in the digestors, and the amount of dilution encountered in the blow pits. It has a pH of about 2 and contains a small amount (0.1 to 0.2%) of sulphur dioxide. The composition of the total solids is 60-70% calcium salt of lignosulphonic acid, about 20% sugars, 6% lime as CaO, and about 10% ash content. When limestone is used, calcium sulphite is the principal inorganic salt present; but magnesium sulphite may be found if the limestone contains impurities of magnesium. Sulphate ions may be present depending on the extent to which sulphur dioxide has undergone oxidation in the sulphur burners and in the digestors during the cooking operation.

So far, the problems involved in the recovery of materials from sulphite waste liquors are too great for universal applicability of such a process (Russell, 1956). Some pulp mill companies in the U.S.A. are continuing research on improving the magnesium oxide sulphite process, which will allow burning of waste liquor and recovery of chemicals (Anon., 1956). The calcium base S.W.L. presents mechanical difficulties in recovery. The ammonium bi-sulphite system is another soluble base development. So far it has not proved practical.

Where it has been found practical and economically feasible to recover S.W.L., utilization has fallen into 3 main categories: (1) Production of ethyl alcohol or yeast by fermentation of the sugars. (2) Burning the organic materials for the fuel value. (3) Manufacture of adhesives and surface active reagents. Difficulties in recovery generally revolve around the process of concentration where the solids content must be increased to 50% or higher.

At one time, serious consideration was given toward setting up an ammonia base process in the pulp manufacture at Port Alice. However, plans for this were abandoned because of the high cost of conversion in plant facilities and inconclusive evidence that the recovery of S.W.L. would prove economical or practical.

For an estimate of the waste materials which are released in the spent liquor at Port Alice, the following data are of interest. The production of one ton of pulp releases one ton of lignin to the sewer. An average of 275 lb. of sulphur per ton of pulp are used. Part of the sulphur, of course, is blown off as gas in the form of sulphur dioxide. About 1/4 ton of fairly pure calcium carbonate is required per ton of pulp. There is about a 2 to 3 percent fibre loss from the screens. Thus, per ton of pulp, there are roughly 2,800 lb. of total dissolved and suspended materials entering the sewer.

Compared to the Kraft process with a loss of about 200 lb. dissolved and suspended materials per ton of pulp, the sulphite

process contributes about 14 times as much polluting substances. The chief difference between the two processes is that almost all the organic materials and inorganic salts are retained in Kraft mills. The organic fraction consisting mainly of lignin is burned and the inorganic salts are salvaged for reuse in the mill.

Gehm (1953, p. 203) gives values of B.O.D. (biochemical oxygen demand) for sulphite pulp production at between 550 and 750 pounds per ton of pulp. For the present production of 220 tons of sulphite per day, the total oxygen demand could range from 12.1×10^4 lb. to 16.5×10^4 lb. per day. With an increase in production to 350 tons daily, the oxygen demand can be expected to range from 19.2×10^4 lb. to 26.3×10^4 lb. per day. Compared to the Port Alberni pulp mill, which has a production of 230 tons of unbleached Kraft pulp and an oxygen demand in the wastes of 8,000 lb. per day, the present Port Alice mill has at least 15 times as high an oxygen demand.

Compared with Kraft mill effluents, S.W.L. is relatively non-toxic to fish and other aquatic life. Lethal doses of S.W.L. varied from 1330 and 2000 ppm. for trout to 100,000 ppm. for rock bass (Water Quality Criteria, 1952).

IV Observed Conditions in Neroutsos Inlet near the Port Alice pulp mill.

Port Alice is located on the eastern shore of Neroutsos Inlet, about three miles from inlet head (Figure 1). Its site at a bend in the inlet provides shelter in the harbour from the direct sweep of up-inlet winds.

A small company town of some 1,100 inhabitants, Port Alice is almost entirely dependent on the pulp mill. The residential sections of the town almost blend into the pulp mill installations, which are located centrally in the community. Domestic sewer lines collect sewage from homes in the townsite and discharge into the inlet by way of the shortest distance. This results in a considerable number of domestic sewer outlets along the waterfront.

Construction was advancing rapidly on the new portions of the pulp mill. It was judged from the stage of the new buildings that the expanded production might get underway sometime in early 1957.

Effluent from the pulp mill enters Neroutsos Inlet in two outfalls about 100 ft. apart discharging directly off the docking area bordering the mill. The two sewers are connected by an equalizing line to reduce the pressure in one sewer or the other. The main outfall discharging about 40 c.f.s. is a large flume-like sewage culvert. It releases its charge into the inlet from a height of about 15 ft. at low tide. Fairly complete mixing from top to bottom occurs in the depth of inlet water below the outfall. (See Fig. 2a).

A large section of the Port Alice waterfront is bordered by a dense band of brownish foam for about 150 ft. offshore (Figure 2b). The heavy band of foam diminishes about half a mile on either side of the outfall. There are discontinuous bands and streaks of foam created by mixing action of wind on the dilute waste liquors more removed from the outfall.

A tide line separating dilute sulphite waste liquor from the sea water can commonly be observed to move past Yreka, five miles to the north of Port Alice. From the air, as observed in a flight from Port Alice to Port Hardy, there are numerous windrows of foam trending parallel to the shores of the inlet and in the direction of the wind. When observed June 1st, during strong southeast winds, this evidence of the sulphite wastes could be noted as far away as the northern end of Neroutsos Inlet and parts of Quatsino Sound. One of the characteristics of S.W.L. is that it tends to foam even in very low concentrations when subjected to wind stirring.

Observations were made along the waterfront for about a half mile north and south of the sewer outfalls. No evidence could be found of any marine animal forms in the intertidal zone. There were no live mussels, barnacles, or sea anemones on the pilings or rocks near shore within half a mile of the outfalls. Only green algae appeared to survive in the region of dense concentration of the effluent. It is not known for what distance along shore and to what depth this benthic sterility extended.

V Currents and Flushing

There is a comparatively small runoff into Neroutsos Inlet. Because Neroutsos Inlet is bordered by relatively high mountains, the drainage area for the inlet is small. Tributary streams are short and swift. Whereas most inlets have a large tributary at the head, Neroutsos Inlet receives only the small discharge of Cayeghle Creek and Colonial (Main) Creek 3 miles south of Port Alice. Like most terminal streams in inlets, these creeks form a tidal estuary of broad mud flats.

Mixing by wind action is very pronounced in all parts of the inlet open to the direct sweep of winds. Port Alice receives shelter from the topography during southeast winds and is more open to northwest wind influence. (When pontoon-equipped planes cannot make safe landings in other parts of Neroutsos Inlet because of heavy chop due to southeast winds, they can usually land without difficulty at Port Alice.)

Tidal currents are weak in Neroutsos Inlet away from the narrow channels of the north end. Wind-driven currents can be quite strong. Stress of the northwest wind piles up water toward the southern end of Neroutsos Inlet resulting in a south-setting current. A return flow occurs during calm following northwest winds. This flow is often referred to as a "relaxation current".

During observations along the Port Alice waterfront, it was estimated that flotsam moved past the wharf at a speed of 3/4 knot. There was little direct wind effect on this material, inasmuch as the wind had subsided locally almost completely. However, the drift was northward against the direction of the flooding tide. Presumably this was still the effect of southeast winds in the northern part of the inlet.

Neroutsos Inlet can be compared and contrasted with Alberni Inlet, which has been thoroughly investigated by Tully (1949). Like Alberni Inlet, it is a dead-end channel, a cul-de-sac. Both inlets are characterized by similar wind systems with respect to the orientation of the inlets. However, southeast winds in Neroutsos Inlet are those which prevail in winter and during periods of storm and adverse weather. Neroutsos Inlet summer winds, corresponding to the afternoon breezes blowing up Alberni Inlet, are from the north.

Neroutsos Inlet lacks some of the features which make Alberni Inlet a system suitable for flushing out the pulp mill wastes. Runoff at the head of Neroutsos Inlet is considerably less than that into the head of Alberni Inlet. The overall runoff of fresh water into Neroutsos Inlet is probably much less than that discharging into Alberni Inlet. Consequently, surface outflow of pulp mill effluent in Neroutsos Inlet can be predicted as being much slower than that from Alberni Inlet.

The outfall from the Port Alice mill is well removed from any streams supporting runs of anadromous fishes so that the concentrated effluent does not block the passage of salmon. However, the method used for releasing the effluent is contrary to the schemes recommended by Tully (1949) for Port Alberni. The concept recommended and adopted at Port Alberni is that effluent be released at the surface without mixing into the sea water. The bulk of the effluent from the Port Alice mill discharges from a sewer at about 15 ft. above lower low tide level. This results in considerable direct mixing with sea water as the effluent cascades into the inlet. What the water conditions at depth are like as a result of this type of discharge is unknown; but there is a possibility of deep-water oxygen depletion and unsuitable conditions for fish life. As pointed out by Tully (loc. cit.), the compensatory up-inlet movement of sea water to replace that removed by the surface flow of fresh water can carry with it waste materials discharged at depth. During decomposition of these wastes, a low dissolved oxygen condition is created and this has its adverse effect on fish life.

VI The Fishery

Runs of salmon up the streams tributary to Neroutsos Inlet are reputedly small. Colonial (Main) Creek and Cayeghle Creek are the largest producers supporting runs of about 2,000 chums, 1,000 coho, and 500 springs. Teeta Creek normally has a

run of about 500 chums and 50 steelheads. Cayuse Creek has had runs of some 100 coho, 500 chums, and 50 steelheads. Nequiltpaalis (Jeune) Creek supports anywhere from 100 to 1,000 chums.

According to a report of the Fisheries Inspector for Area 27, (Hooser, 1956), some fluctuations of the salmon runs in streams tributary to Neroutsos Inlet have occurred. However, it was noted that at present the runs are holding their own with possibly a slight decrease over the period of time that the Salmon Report Forms (B.C. 16) cover. No evidence was found by Inspector Hooser that at any time had there been an undue adverse effect of the effluent on the salmon which penetrate the tributary streams in Neroutsos Inlet. Scrap fish of the cod family were reported by him to be found in and near the beaches at Port Alice.

A report from Captain T. Dancy of F.P.V. "Pholis", received through Mr. W.P. Wickett dated July 20, 1955 stated that 4 dead "rock bass" were found at a distance of 1.1 nautical miles from the Port Alice outlet. At points 0.9 and 0.7 n. miles from Port Alice, 10 more dead rock bass were found during the same morning. These dead fish were found after a lower low tide following a period of about a week of dry weather. Pollution from the Port Alice pulp mill was suggested as the cause for the fish kills. However, there was insufficient evidence to prove or disprove this possibility.

In the past there have been several attempts to evaluate the pollution from the Port Alice pulp mill. An investigation into the problem was apparently conducted by Dr. Charles H. Williamson during about 1927 (Tully, personal communication). No record of this work has been located.

There is no fishery of commercial importance in Neroutsos Inlet. It is doubtful whether there has been sufficient pollution in the past and whether it can be expected in the future to the degree that it might have an economic effect on the fishery. However, there is little doubt that in the course of time with the continuous release of wastes into the inlet waters, there has been a change in the biotic environment of the inlet particularly in the vicinity of the Port Alice pulp mill.

VII Summary

The sulphite pulp mill at Port Alice, V.I., is undergoing expansion from a production of 220 tons to 370 tons per day. This expansion is designed for a more efficient use of the present fresh water supply of 29,000 g.p.m. None of the S.W.L. is treated or recovered. The wastes from the expanded mill will not be increased in volume but will be increased in concentration by roughly 2/3.

Sulphite Waste Liquors contain in solution or finely divided suspension approximately half of the weight of the wood used in pulping. They comprise fibre-binding substances such as lignin and pectin, fibrous material mainly as hemicelluloses,

and the added inorganic compounds such as sulphur dioxide, sulphites, polythionates and calcium. Because of their high organic content, the wastes have a high B.O.D. Acid in reaction, they have a persistent pungent odour and a tendency to foam in receiving waters.

The B.O.D. of the present mill wastes at Port Alice is about 15 times as high as that of the existing Kraft pulp production at Port Alberni.

No intertidal animal life was observed within one-half mile of the outfall. There are no biological or oceanographic data on Neroutsos Inlet. It is predicted from runoff characteristics that flushing of wastes there is not as rapid as that in Alberni Inlet. The dissolved oxygen concentrations in deep waters of Neroutsos Inlet are probably much lower than those in Alberni Inlet because of the mixing of effluent into the deep water at the outfall and because of its high B.O.D.

No fishing of commercial importance exists in Neroutsos Inlet. The pulp mill expansion is not anticipated to have any significant effect on the fishery. It is recommended, however, that modifications be made in the outfall so that effluent will not cascade into the inlet but will flow over the sea water with a minimum of turbulence (see Tully, 1949, p. 120). This will also reduce the foam problem.

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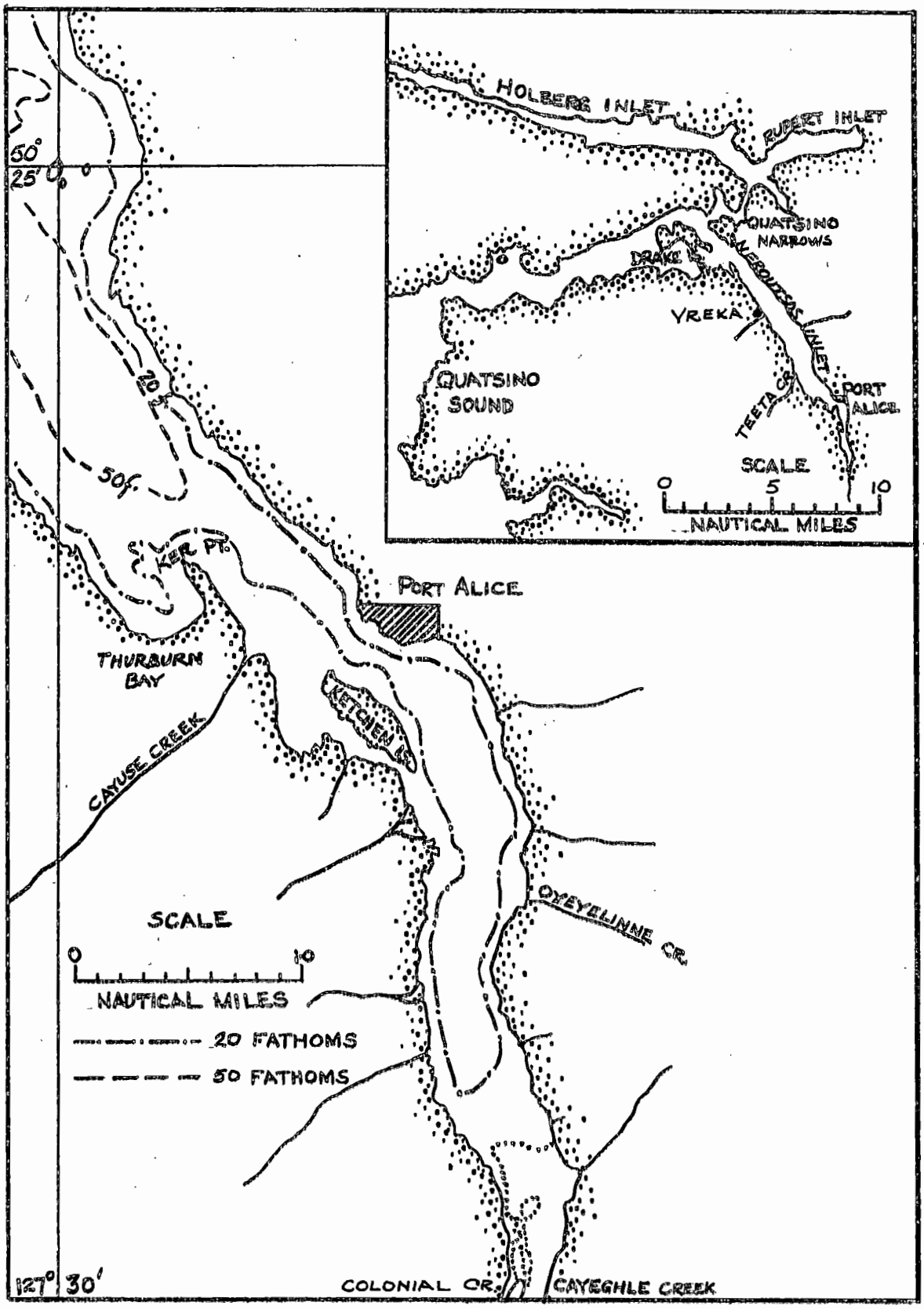

Figure 1. Chart of Neroutsos Inlet showing the location of Port Alice.
Inset: General location of Neroutsos Inlet on the northwest coast of Vancouver Island.

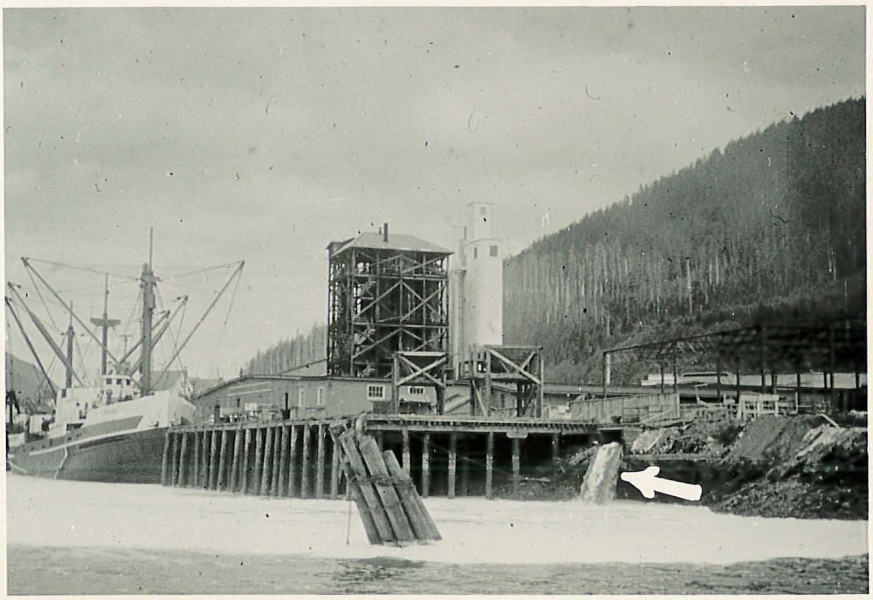

Figure 2a - Photograph of Port Alice pulp mill from waterfront. Arrow points to outfall. Foam from S.W.L. shows as white layer on water in foreground.

Figure 2b - Photograph of Port Alice townsite and waterfront north of pulp mill. Note foam band trending parallel to shoreline.