Engineering Problems of Waterfront Construction in the Northwest Logging Industry

by

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Approved:

[Signature]

Professor of Logging Engineering
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For much of the information and especially for the itemized costs contained herein appreciation is due to Mr. Charles B. Dunham, Logging Engineer for Bloedel, Stewart & Welch, Ltd., Port Alberni, B. C., and to Mr. Hyden P. Ellis, Logging Engineer for Crown Zellerbach Corporation of Neah Bay, Washington.

Some of the pictures were supplied by The Timberman, The West Coast Lumberman, and by Mr. Harry B. Forse, Prince George, B. C.

The poem is dedicated to Professor H. R. Patterson and to Mr. C. J. Budelier to whom it is particularly applicable.
THE BUILDER

An old man travelling a lone highway

Came at the evening, cold and gray,

To a chasm deep and wide.

The old man crossed in the twilight dim,

For the sullen stream held no fears for him.

He turned as he reached the other side,

And he built a bridge to span the tide.

"Old man," said a fellow pilgrim near,

"You are wasting your strength,

With your building here."

Your journey will end at the close of day,

And you never again will pass this way.

You have crossed the chasm deep and wide;

Why build this bridge at eventide?"

The builder raised his old gray head.

"Good friend, on the path that I've come," he said,

"There followeth after me today

A youth whose feet must pass this way.

This stream, which has been naught to me,

Might to that fair-haired youth a pitfall be.

He, too, must cross in the twilight dim.

Good friend, I am building this bridge for him."

--Anonymous--
INTRODUCTION

This subject was chosen for a seminar paper because it was found after a perusal of the technical trade journals and the college library and the Forest School library files that no person has written on this subject nor any part of it to any extent. One article was found entitled, "Loading and Unloading," but the writer forgot to include the "Unloading" portion of the article! To my knowledge, no person has attempted to show the importance and magnitude of difficulties encountered by Logging Engineers and operators in the selection of a booming ground and the other problems encountered in waterfront construction that are so often encountered in new logging operations.

It is my hope that I will be able to show here that engineering practice applied to this type of construction can be, and is, a profitable investment. It is unlikely that this paper will be widely circulated, but it shall have served its purpose if it convinces only a few Logging Engineering students that there is quite often more than one solution to a field problem, and that thinking ahead a few years pays dividends to both oneself and one's employer.

Two large operations have been used to illustrate the fact that booming and waterfront construction actually do represent a large problem and often do account for a large capital investment, and are, therefore, a challenge to the Logging Engineer to perfect new systems, improve old systems, and reduce operating costs in general.
Both examples are railroad operations and therefore involve a relatively inflexible type of transportation equipment, which creates in itself a more complex problem. There are many logging operations using trucks that are never faced with similar problems; however, it is hoped that these examples may prove interesting and useful to the casual student who does not know for sure that he will be employed by a "railroad" logger in the future.

In using these examples it is not intended that they be considered the perfect result of engineering planning, but rather that these cases do represent good engineering practice and are, therefore, worthy of note.

**LOG BOOMING**

Log booming serves two purposes, which are the storage of large groups of logs in the smallest possible space and the transport of logs from place to place in a fashion that will insure the easiest towing and the least possible loss of material.

This aspect should be of interest to the Logging Engineer because as timber stands become more remote, logs are transported longer distances to sawmills, which, in turn, involves various types of booms and rafts for transport and storage. This type of construction often falls into the Logging Engineer's department and he is often expected to know how to construct various types of booms and rafts. A description of some more popular types of rafts will be given here, but first it might prove interesting to review briefly the evolution of log booming and towing as it is recorded in the various trade journals.

**History of Log Booming**

Log booming has been a part of the lumbering business ever since
milling first started and logs were collected in a group and taken to a mill. As logs were transported further distances and in greater quantities and through rougher water, it became necessary to design methods of rafting that would withstand the pounding and buffeting of the ocean while enroute to their destination. Many attempts were made and many failures experienced but eventually several designs came to be known as being cheap in construction and safe in transport.

The first ocean going raft was constructed by Captain H. R. Robertson of St. John, New Brunswick, in the late 1890’s in a land cradle. Captain Robertson had great difficulty, apparently, in launching this raft after its construction on the land because of its great weight. He was successful in the launching because history credits him with transporting this first log raft containing 110,000 lineal feet of piling from St. John, New Brunswick, to Boston, Massachusetts. After this successful venture Captain Robertson designed a floating cradle and found this far more satisfactory from the launching angle.

His next venture was the construction of two rafts at Coos Bay, Oregon, in 1891 and 1892. Both of these rafts were lost while enroute to San Francisco.

A cradle was then built at Astoria, Oregon, in August of 1894 and towed to Stella, Washington, where a raft was built. This raft broke up on the Columbia bar and was a total loss. However, in 1895, Captain Robertson constructed another raft at Stella, Washington, and this raft got as far as the Golden Gate before breaking up and was only a partial loss, since reports indicate that over 60 per cent of it reached its destination at San Francisco.
Captain Robertson had received a good deal of experience in building these rafts by this time and it was thought by many progressive individuals that this was a good means of log transportation for long ocean voyages. Therefore, in 1896, it is reported that Captain Robertson, together with the Port Blakeley Mill Co., built an expensive cradle in West Seattle, Washington, for the construction of rafts for this company. One raft was built and successfully landed in San Francisco and the second raft arrived with only a small loss of material. Apparently this business was a paying one, because a good profit is reported from this venture even though a portion of the tow was lost enroute. It was found that the marine borers had destroyed the cradle at West Seattle in the two-year period, so it was decided to confine future raft building to the fresh water sloughs of the Columbia River. Two more rafts were built at Stella, Washington, and one at Westport, Oregon, and all three were safely landed at San Francisco.

Captain Robertson then formed a partnership with A. B. Hammond, and a large number of rafts were constructed in the following years. Reports indicate that only two rafts were lost in several years.

In 1906 it was decided that it would be a profitable venture to raft logs to southern California to the city of San Diego, and the principals of the Benson Timber Company entered the timber rafting business at the mouth of Wallace Slough, Oregon, on the Columbia River. Mr. S. Benson and Mr. C. J. Everson, the principals of this company, employed a Mr. Fastabend as superintendent of construction. A simple cradle was designed by Mr. Fastabend and Mr. Everson, which had an improved centre locking device which distributed the strain from the tow-line more equally throughout the raft, thereby reducing the chances of break-up due to excess strain in one
part of the raft, as had formerly been the major difficulty and one of
the reasons for so many losses while towing.

It is interesting to note that up to 1933 Mr. Fastabend, now an
erly man, had supervised the construction of 99 rafts, of which no
losses were recorded. Since 1933, several more rafts have been completed
and shipped, but in 1941 two rafts were partially lost, and the latest
reports indicate that for the year 1942, at least, there will be no rafts
sent from the Columbia River to San Diego.

Types of Log Booming

Since a history of the construction of ocean-going rafts has been
given, it might be interesting to review briefly the various types of
ocean rafts constructed in the present day, a description of how they are
constructed, and the requirements in the form of booming grounds and
equipment usually used in this construction.

The Benson Raft

The development of the Benson raft has been described above. Although
not very widely used, these rafts are still constructed, so will be included
here.

The cigar-shaped raft is built in a cradle, which is in sections so
that it can be removed when the raft is completed and then used again for
future rafts. Tree length or long logs are preferred, as a rule, because
they provide the necessary lap and in this way provide a backbone for the
raft, which then resists the action of the water as the logs are loaded
into the cradle.

When the raft is about one-half completed, a $2\frac{1}{2}$ inch stud anchor chain
is run through the centre of the whole raft from end to end. Other chains
are shackled to this center chain and are then attached to the circle chains at the ends of the raft (see Plate 1). A tow chain is then attached to one of the circle chains near the end of the raft and the rest of the raft built on top of this, thereby binding the circle chain securely, and supplying an emergency tow chain.

The majority of rafts are constructed 720 feet long by 52 feet wide and 34 feet deep. The largest raft was 1000 feet long by 52 feet wide and 37 feet deep (see Plate 2).

A large amount of chain is used and this is perhaps one drawback to this type of log boom construction, because this chain must be shipped back from San Diego after each raft is broken up at that point, and this is an expensive item, since there is approximately 120 tons of chain on the 720-foot-long raft and 160 tons on the 1000-foot-long raft. It is estimated that the cost of chain for the 1000-foot-long raft was close to $17,000.00. This raft took 3 months to build and contained some 7,000,000 board feet of timber and was constructed at a cost of approximately $1.25 per M. board feet. Towing figures are given as being contracted for $1.50 per M. board feet from Wallace Slough, near Marshland, on the Columbia River, to San Diego, California, a distance of some 1200 miles.

Apparently this method of towing logs is not altogether too successful because the newspaper, The San Diego Union, reported on January 4, 1942, that no rafts would be towed in 1942 and that it was not likely that this type of towing would again be tried until after the present war. No reasons were given for the discontinuance of the venture, but it is quite likely that it is partially due to the two reverses suffered by the company in 1941 with the loss of two rafts while enroute to San Diego. One raft was
broken in two off the central California coast, but the two sections reached their destination. The second loss was caused by the destruction of the boom by fire while enroute, near Fort Ross, north of San Francisco. The source of the fire was unknown but critics of this rafting system claimed that it was due to the friction of the steel binding chains as the logs were buffeted by heavy seas. Investigation by marine underwriters and government agents failed to confirm or deny these allegations, however.

The fact that the cradle used in the construction of these rafts is badly in need of replacement, which might be prevented by war priorities; and the fact that long logs, which are preferred in this construction, are becoming more difficult to get at the present time due to the ready market for shorter logs were probably factors considered by the Benson Timber Company in postponing until after the war the construction of these ocean-going rafts.

Plates 1 and 2 show two views of the Benson type raft.

The Kelley Log Raft

The Kelley log raft was invented by T. A. Kelley, of Vancouver, B. C., and patented in November of 1923. Mr. Kelley owned and operated a logging company in the Queen Charlotte Islands, off the coast of northern British Columbia, and sold his logs in the open market at Vancouver, B. C. Due to the fact that the logs had to be transported for over one hundred miles through the open sea, a type of raft that would stand a heavy buffeting was necessary and this led to the development of this type of raft.

In the construction of this raft, logs are first secured for the sides. Four sticks 125 feet long are usually selected. Two of these logs are butted together and fastened with chains and at the joint another log about 80 feet in length is placed on the inside and strapped to the other two logs
by cable, thereby making a "stiffleg". The side sticks are then spaced
about 70 feet apart and a spreader log is inserted at one end, but the
other end is left open, thereby forming a pocket between the "stiffleg"
sticks. This pocket is then filled with 40-foot logs in sets and the open
end is closed. These sets of 40-foot logs are then laced to each other
and to the sides by heavy wire rope. The lengths of this wire rope decrease
toward each end of the raft, thereby forcing the raft to form a tapered
shape. It is approximately 70 feet wide in the middle and 59 feet wide at
each end.

Logs are placed on this "floor" which was created by lacing the
bottom section together, and are so arranged that the ends of the logs will
come out even at the bow and the stern after a full load has been placed on
the floor. These logs on the "floor" of the raft are strapped down by
cable straps which run over the top of the raft and under each side stick
or "stiffleg". Each of these straps is tightened by a donkey and the ends
clamped on top in the centre of the raft.

The result of this construction is that a raft is produced that narrows
at each end and is higher at each end than in the middle. This gives a
streamlined effect to the tow and really reduces the tendency of the logs
to shoot out when in a heavy sea. It also reduces the water friction
because the tow is somewhat the same shape as the towing vessel.

This type of raft has been used to quite an extent in northern British
Columbian waters and has been relatively successful, but seems to have had
little use, if any, in the Northwestern States. It is regretted that no
photographs are available of this type of ocean raft design.
The Gilbert Timber Raft

One type of timber raft that probably has never been used in America and probably never will be built in America, but which is interesting from the standpoint of invention being the mother of necessity, is the Gilbert Timber raft. This raft was used in Europe during the first World War in 1918 and 1919 when few ships were available for the transport of lumber, due to the necessity of the transport of food from the Americas.

The raft was originated by W. Villa Gilbert of London, England, as a maritime necessity measure and proved quite successful. Some one hundred million feet of timber were moved from Trondheim, Norway, to Ipswich, England, with no loss of material, in a series of rafts of this design.17

The rafts were made of sawn deals and battens abutted side by side and end to end to form a mass in which the vertical joints in the adjoining layers are staggered so that the planks are interlocked.

The entire raft was encircled by straps which are connected by screw couplings and tie-rods which run through the raft vertically. To strengthen the raft against horizontal deflection, horizontal plates were built in at the bow and connected by stringer cables supported horizontally along opposite sides of the raft.

A rudder was connected to the stern plate and when in tow steering was controlled by a man who rode the raft amidships in a semi-sheltered position. It was claimed that this facilitated towing to a great degree and that when weather was too rough for a man to ride the raft that it was not practiced.

The Davis Raft

An excellent discussion of the Davis raft was found in the Timberman magazine and in the publication Timber Topics. These articles contained
all the technical construction data that is of value and since it would be difficult to improve on this description, it will be quoted here and some photographs and cost figures for this type of construction will follow.

"For towing logs in the coastal waters of the North Pacific, perhaps the most successful type of raft yet developed for all-around service is the Davis raft or modification of that type. The Robertson or Benson raft used on long tows from the Columbia River to San Diego represents a particular type for a specific purpose, and while highly successful over a long period of years may be eliminated from this discussion. The Benson system is based on a point to point delivery, always fixed, and requiring a good deal of standing gear, such as a wooden cradle, etc., applicable only to fresh water conditions.

"The Davis raft has been used all along the coast from Oregon to the islands comprising the Queen Charlotte group in British Columbia. The Davis raft was developed by G. C. Davis, while a resident of Vancouver, British Columbia.

"The Davis raft is admirably suited to British Columbia waters and hundreds of million feet are delivered to pulp and paper mills and sawmills along the Canadian coast by this system. The construction of a Davis raft is an art in itself, and the men in charge of the rafting crews are experts, second to none in their own line.

"Choice of the proper site for construction is of the utmost importance, since the water must be of a reasonable depth, as the completed raft draws from 20 to 30 feet of water, on the average, and must be constructed in a sheltered bay or inlet.

"The framework of the "crib" is first laid out. For a typical raft, two 100-foot logs, chained end to end along each side, form the side pieces, with 70-foot sticks forming the ends. This 200 by 70-foot oblong is then filled with floating logs in five sections; two sections of 40-foot logs at each end and a 50-foot centre section. The outside frame, technically known as "side sticks" are approximately two feet in diameter.

"When the framework has been laid and chained and the first layers of logs dumped in, the difficult work of building the boom commences. The next step consists of the intricate task of lacing these logs with heavy cable to form the "bottom." To accomplish this, cable is fastened securely to one side stick and then laced through, over and under each log, and secured on the opposite side. Four such lines are woven through each of the four end sections, with six in the middle to give added bolstering where the strain is the greatest. These 1 1/2 inch cables are not drawn tight, from 16 to 20 feet of slack being allowed in each, depending upon the proposed size of the raft.

"The completion of these preliminary steps gives the logger a firmly interlaced bottom of logs laid in uniform lengths, and bound together with heavy cable.
"Logs are then rolled in until the gradually sinking pile has taken all the slack out of the cables. About the only equipment needed, outside of a small boom boat to move the logs into position, is a donkey engine mounted on a float, with an A-frame structure for the accommodation of the lines.

"The logs are hoisted and rolled into position in par-buckled layers. As each layer goes into place, the slack in the cables lacing the bottom is taken up, and the center gradually sinks beneath the water. When the cables become tight and the side and end sticks begin to submerge, the raft is more than half completed and more cables are then needed. The average raft will contain about 700,000 board feet and will be down into the water about 30 feet.

"Binder lines of heavy steel cable are now drawn from side to side across each end section, with two across the middle. When these have been securely fastened at each side and drawn reasonably tight, more logs are worked into place, being built up into a pyramid until a peak is reached. As the side sticks sink, cable which has been attached in advance, is interwoven through the logs as they go into place, resulting in a firmly bound raft, which, like an iceberg, has the larger portion of its volume below the water surface."

Davis rafts are, undoubtedly, the most widely used type of raft for deep sea towing, and the majority of rafts from the Queen Charlotte Islands to the pulp mills at Powell River and Ocean Falls, B. C., and to the open market in Vancouver, B. C., are transported in this way.

Loggers in the Strait of Juan de Fuca and the west coast of Vancouver Island are forced to Davis raft their logs rather than flat boom them because of the heavy seas encountered in that area and because of the treacherous currents.

The cost of constructing Davis rafts seems to be a somewhat variable figure depending upon the conditions under which the raft is built. Bloedel, Stewart, and Welch, Ltd., at Franklin River, B. C., built Davis rafts during the years 1938 and 1939 for the purpose of shipping selected cedar to their mill in Vancouver, B. C., and again during 1940 and 1941 for the purpose of shipping rafts of their excess hemlock and white fir to the pulp and paper mills in Port Angeles, Washington. This company reports
the cost of 85 cents per M. board feet. A crew of ten men were used and it took ten days to build a raft containing one million board feet.⁵

Crown Zellerbach Corporation at Neah Bay, Washington, are forced to Davis raft their logs from their camp near the tip of the Olympic peninsula to their mills in Port Angeles. The logs are rafted as fast as they are dumped from the trains and it takes a crew of 9 men approximately 1½ days to build a 400,000 board foot raft.

Construction costs are given as follows:⁸

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
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<tr>
<td>Sorting and Rafting</td>
<td>.550 M. Bd. Ft.</td>
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<tr>
<td>Repair Labor</td>
<td>.020 M. Bd. Ft.</td>
</tr>
<tr>
<td>Repair Material</td>
<td>.051 M. Bd. Ft.</td>
</tr>
<tr>
<td>Wire Rope and Rigging</td>
<td>.062 M. Bd. Ft.</td>
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<tr>
<td>Fuel Oil for par-buckle</td>
<td>.026 M. Bd. Ft.</td>
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<td>Lubricants</td>
<td>.006 M. Bd. Ft.</td>
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<tr>
<td>Total Cost to Raft</td>
<td>$0.876 M. Bd. Ft.</td>
</tr>
<tr>
<td>Towing to Port Angeles</td>
<td>.650 M. Bd. Ft.</td>
</tr>
<tr>
<td>Marine Insurance (Average)</td>
<td>.150 M. Bd. Ft.</td>
</tr>
<tr>
<td></td>
<td>$0.800 M. Bd. Ft.</td>
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Total Cost to build Davis Raft and Tow $1.676 M. Bd. Ft.

Plate 3 shows a Davis raft of hemlock in the Queen Charlotte Islands ready for shipment to Ocean Falls, B. C.

The Vancouver Daily Province reported the largest Davis raft ever to enter the Fraser River as containing 2,500,000 board feet of hemlock and spruce.¹⁰ This raft was 450 feet long and drew 30 feet of water and it is reported that it required 22 days to tow it from Masset Inlet, Queen Victoria.
Islands, to the Fraser River. It would be interesting to compare the costs of this raft and the cost of building the Benson rafts, since a Davis raft of this size is approaching the volume content of a Benson raft.

Flat Log Booms

The general and most widely used type of log boom is the flat boom. Wherever logs are towed in rivers or in inland waters where they are exposed to very heavy swell or heavy seas, these flat booms are used.

Logs are simply enclosed within boom sticks which are fastened together, end for end, by heavy boom chains. These boom sticks are laid out in the form of a rectangle, usually 7 or 8 sticks long by one stick wide, and logs are sluiced inside the enclosure so that they lie end to end and side by side and so that they fill the entire enclosure. Two methods are used to secure these enclosed logs so that they will not slip out between the boom sticks nor under the boom sticks in rough water. The first method is the use of swifter lines, which are usually galvanized cables that are strapped around each boom stick at the midpoint of the boom stick, where the greatest strain comes upon the stick, and then passed across the entire width of the boom and strapped around the corresponding boom stick on the other side and drawn tight by a small winch or by a power unit of some type. The second method of securing the enclosed logs is by the use of swifter sticks. These sticks are laid across the width of the boom from boom stick to boom stick and are then fastened by a chain from the end of the boom stick to the end of the swifter stick. Swifter sticks are far superior to swifter lines but require a fairly good sized power unit to lay on the boom and, of course, take more time to put on than the swifter lines; but as well as holding each set of boom sticks tight it has the effect of holding its own weight (see Plate 4).
The cost of flat booms depends upon many variable factors, too. These might include wind, tides and currents, depth of water, and swell from the ocean, and perhaps not the least factor is room to sort. The more ideal the conditions the less the cost of sorting and booming. While costs may not seem to vary a great deal, it should be remembered that even a small additional cost on a large volume of timber will eventually amount to a large sum of money. One case where this can be proved to be true is the case of Bloedel, Stewart and Welch, Ltd., at Franklin River. An excellent bay was available for dumping and booming at Franklin River and an excellent deep water booming ground was constructed (see Drawing 1 and 2 for booming ground and layout) to take care of the timber in the Franklin River drainage area. When this area was logged off the company commenced tapping a large body of timber some few miles to the south in the Coleman Creek drainages. An old Canadian National Railway grade connected the two areas, but this old grade had never been used and there were some 1500 lineal feet of bridges to be built on very rocky ground and at a high cost. Because of the excellent booming facilities at Franklin River and the very mediocre booming conditions at the only possible dumping place at the outlet of Coleman Creek, the company decided to repair this old railroad grade and to build the bridges. Until some figuring is done in this case it might seem a foolish move to build an additional five miles of railroad and some $15,000 worth of bridges when a booming ground actually was available near the new stand of timber; but by the far-sightedness of the engineer, the company was able to save a considerable sum of money.

The cost of rebuilding this old railroad and building these bridges amounted to $20,000.00, and on top of this there is a charge per M. board
feet for the transportation of some 600,000,000 board feet of logs over this five mile stretch. When this was done the company knew that booming would cost them 15 cents per M. board feet, because that is what the cost had been for some years at Franklin River log dump.5

The cost of booming at Coleman Creek would have included a new log dump at approximately $10,000.00 and a new machine shop at another $10,000.00, or a total of $20,000.00 in all, but due to insufficient room to sort logs at Coleman Creek the logs would have to be towed to Franklin River booming grounds for sorting at an estimated cost of 15 cents per M. board feet. This charge on 600,000 M. board feet would amount to $90,000.00, and this plus the extra $20,000.00 for the new dump would amount to $110,000.00 as against the charge of $20,000.00 for the new grade and an unestimated charge for the railroad transportation of the logs over the six miles of line.

Another example of good planning can be seen at the Menzies Bay operation of Bloedel, Stewart and Welch, Ltd., on the east coast of Vancouver Island. Here an extra mile of railroad was built to the head of Menzies Bay to get away from fast tides that would have allowed logs to be sluiced only at certain stages of the tide. At a later date the Campbell River Timber Company built a booming ground and log dump in a place where the tides were fast and booming cost this company 20 cents per M. board feet as against 12 cents per M. board feet for Bloedel, Stewart and Welch. A saving to B. S. & W. through far-sightedness and good planning in building the extra mile of line resulted in a saving of 8 cents per M. board feet over a volume of close to 4 billion board feet, or an amount close to $230,000.00 within a 20-year period.
Bloedel, Stewart and Welch report that at former operations at Myrtle Point and at Union Bay, B. C., that booming cost 25 cents and 35 cents respectively because of the exposed position of the log dump and booming grounds.5

Barging Logs

One method of transportation that has gained popularity with the past few years is that of barging of high grade logs. An old sailing vessel is often used, after being stripped down to a bare hull. Low barges are also used at times.

The usual method is to fill these barges with high grade logs, usually peelers, and tow them to a market for sale. Of course a barge is not used where the logs do not have to be transported through rough water because a flat boom would do in any calm water and is a cheaper method than barging.

The Alberni Pacific Lumber Company of Port Alberni, B. C., which is one of the H. R. MacMillan Company holdings, used this method for transporting peeler logs from near Port Alberni, where there was no plywood mill at the time, to one of their Vancouver, B. C., plywood plants. The rumored cost of loading the barge was 45 cents per M., and the cost of unloading would be almost as much. A unique method was adopted at this operation to avoid hoisting the logs the distance from the water up to the hatch of the barge and then into the hold. This was to open a valve and let water into the bottom of the hold, thereby lowering it in the water until only a few feet of freeboard were left. The logs were then parbuckled into the hold and as the vessel dropped lower in the water the water inside was pumped out so that there were never more than a few feet of freeboard which needed contending with.
An interesting sidelight was that the converted log-carrier was the former sailing vessel, The Border Queen, which for many years was the notorious mother-ship for the rum-fleet in the days of prohibition, and operated off the Mexican Coast.

**Bag Booms**

Bag booms are used for small parcels of logs and for storage purposes only, and are seldom seen because of their limited usage. Because of the fact that logs are not stored for a long period in the pine region, due to the quick stain that takes place, this type of boom is often used at an Eastern Oregon mill for log storage for short periods of time. Plate 5 shows logs stored in a so-called "bag boom" at Klamath Falls. Plate 6 shows Ponderosa pine logs on a flat car ready for unloading at an Eastern Oregon log dump.

**LOG DUMP AND BOOMING GROUND LOCATION**

A booming ground is usually laid out in conjunction with the log dump and each structure is dependent upon the other for efficiency and economy of operation. It is practically impossible to lay down any hard-and-fast rules for laying out these structures because of the great number of variable factors entering into this type of planning.

Perhaps the chief variable in a railroad operation is that of the mainline railroad. It is the location of this line that sets the dumping place. Both are interdependent and this becomes more apparent as one goes north along the Pacific coast and encounters long narrow valleys of timber running back from the coast for many miles through glaciated valleys. In these cases there are very often only one or two places where a log dump
can be built. Sometimes it is the mouth of the river draining the area or in a small bay if one is available near the mouth. Often it is impossible to boom where the logs are dumped because of a lack of space or because of fast tides or heavy winds, or sometimes the foreshore rights are simply not available. Each and every location offers a different problem but the engineer can overcome many obstacles by planning, and it often happens that advantage of natural factors can be made. Examples of this are the laying out of the sorting grounds so that prevailing winds, tides, and river currents help rather than hinder the sorting.

The size of the logging operation and the type of transportation used are often controlling factors in this layout, too. Trucks do not require the extensive log dumping facilities that railroads require because the equipment is more flexible and a smaller volume is usually dumped over a dump by a truck operation than by a railroad operation.

The Franklin River Booming Ground and Dump

At Franklin River, B. C., Bloedel, Stewart and Welch, Ltd., were fortunate in having available a small deep-water bay at a point where the main line was easily terminated. A former railroad grade, built by the Canadian National Railroad, paralleled the shore of a semi-circular bay, and since the main line took off from this old grade, it was a good show to use a trestle across the end of the bay for a dumping trestle and then join in with the Canadian National grade on the other side of the bay again. In this way the Canadian National grade was used as a tail-track and as a camp line into the machine shop and the camp. (See Drawing 2 for a detail of the dump and adjoining railroad lines.)

The part of the trestle to be used for a log dump was in some 40 feet of water and the boom lay over an area ranging between 40 feet and 300 feet in depth, so it was impossible to consider the regular type of booming
ground where dolphins are used for anchoring the booms. A system of anchors was laid out that would rise and fall with the tide and systems of cables used the rocky shore on one side for the main anchor. The system used is rather unique and has proved very successful over the eight years it has been in use. There is very little maintenance work necessary, which is in itself an unusual feature of a booming ground. (See Drawing 1 for details of the booming ground layout.)

The Sail River Log Dump and Booming Ground

An unusual problem was encountered at Sail River, which is near the tip of the Olympic peninsula. That area is open to the sea with practically no harbors or bays for protection against the ceaseless pounding of the ocean rollers. It was necessary for Crown Zellerbach Corporation, therefore, to construct their own booming ground in the mouth of Sail River. (Drawing 4 shows the contours and the general outline of the area before any dredging was done in 1934 and 1935.) The job done here was literally to dredge out the entire mouth of Sail River to a depth that would allow dumping at low water and Davis raft construction at the same time, since it would be impossible to build an area large enough to store any great volume of logs. (Plate 7 shows the river just after dredging commenced, Plate 8 shows it at about the half-way point, and Plate 9 shows it nearing completion.)

Bulkheads were constructed to hold back the sand-gravel banks before the dredging was started and then a large water dredge and a dragline-shovel disposed of the dredged material behind these bulkheads. The material that remained after the bulkheads were filled was loaded into a centre-dump scow and hauled out and dumped into the Straits by tug. (Drawing 5 shows the area as it is today and Drawing 6 is a cross-section of the log dump that was constructed.)
It is interesting to note that, since this is in the mouth of a small river, the problem of silt deposited by winter freshets must be contended with and this cost is reported to be close to $5000.00 per year. An exhibit accompanies this report to show that planning can be done accurately. The chief engineer of the Crown Zellerbach Corporation was kind enough to supply a list of both the estimated and the actual cost of this dredging operation. The estimated costs are, in many instances, very close to the actual figures, which indicates a thorough job of engineering.

UNLOADING SYSTEMS

There are only a few methods of log unloading that are used in the industry. Log unloading is relatively a simple operation, but here, too, by good planning and good initial construction, it is often possible to save a few minutes with each trainload of logs dumped, thereby creating a considerable saving over a long period of time.

The important log unloading systems are the par-buckle system, the log unloading machine, and the whirly or jill-poke system.

Par-buckle System

The oldest method of dumping logs seems to be the par-buckle system. This system is popular with both truck operators and railroad operators. It is a good system and there is really little expense involved after the original investment is made.

A gin-pole or an A-frame is rigged so that a system of blocks hangs from a point outside of the brow-log. A cable passes from a set of drums out through the system of blocks, and when a load of logs is to be dumped the end is taken under the load and attached to the brow-log or to some other immovable object. A power engine is used to operate the drums and
the load is thereby par-buckled off the truck or skeleton car into the water. An old gasoline donkey or an electric engine, where the electric power is available, are used to furnish the power for the operation of the drums. Where these systems of power are used it is usually necessary to have an extra man on hand to operate the dumping rig, but some of the new truck dumps have an ingenious system of operating the entire rig from a set of push buttons, and the truck driver is the only man needed to operate the system. The truck trailer is usually loaded onto the truck for the return trip to the woods by the machine after the load is dumped.

An illustration of this system can be seen in Plate 10 which shows a par-buckle dump at Euwana Box Company’s mill at Klamath Falls, Oregon. The usual log dump used with this system is often of simple construction especially for truck operations. An example of this may be seen in Plate 11, which is the log dump of the Big Lakes Lumber Company at Klamath Falls.

The chief disadvantage of this system is that where a train-load of logs is being dumped it is necessary to stop the train and fasten the par-buckle line under each load as the cars pass the brow-log. It often requires, therefore, as much as a half hour to dump a twenty-car train.

The Movable Dumping Machine

This is a method used purely for railroad operations and is used chiefly in places where long trains of logs are dumped into shallow water. This method is necessary because logs cannot be dumped in a high pile onto the mud bottom or into shallow water because even an exceptionally high tide might not raise them. Therefore, it is necessary to dump them car by car over the entire length of the dump.
A double track trestle is a requisite in this type of dumping because two sets of tracks are necessary, one for the log-train and one for the unloading machine. The machine travels along on its own power along side of each car of logs. An arm, operated by power, simply pushes the logs off the skeleton cars after the blocks have been tripped. The chief objections of this system are that the initial cost of the trestle is high and the initial cost of the machine is high. Figures on the costs of these machines were, unfortunately, not available, since they are constructed only by special order.

This type of unloading is practiced by the Elk River Timber Company at Campbell River, and by the Comox Logging Company at Cootenay, B. C. In each of these cases log trains of forty to seventy cars are dumped in 15 to 25 minutes. The Weyerhaeuser Timber Company at Klamath Falls uses this type of log dump on the shallow Klamath River. However, this company has deviated from the usual in this dump by doing away with the standard type of brow-log usually used. The usual log-dump has 500 to 1000 lineal feet of brow-log and fender-piling, depending upon the length of the dump, but at Klamath Falls the company has driven the outside pile of the trestle closer to the centre of the bent and has done away with the brow-log entirely. The outside end of the bunk upon which the logs rest is about two feet out past the edge of the log dump when the dumping is taking place. Then as the logs are dumped they fall clear of the trestle and do not bump the outside piling, and maintenance is then not a major item. Plates 12 and 13 show the log unloader and the trestle at the Weyerhaeuser dump at Klamath Falls. The outside edge of the dump can be seen as described.
Bloedel, Stewart and Welch are constructing a double-track dump at Shoemaker Bay near Port Alberni at the present time, since they are forced to dump into shallow tidal water at this new operation. The trestle is 800 feet long with 600 feet of brow-log, containing some 300 pieces of cedar piling. The cost is reported as being approximately $12 per lineal foot.6

The Whirly

The whirly is probably the fastest, cheapest and most efficient method of log unloading used at railroad log dumps in the Pacific Northwest. It is not a new structure but for some reason doesn't seem to have a very wide usage. Several types of this rig are in use throughout the country but the one that is probably the best is the type described in Drawing 3.

The drawing of this device needs little explanation, but to sum it up briefly, it consists of four arms, each at right angles to each other, which revolve around a 15 1/2 inch piling, which is set in the centre of a two-layered dolphin. The first layer contains 20 piling and the inside layer contains 12 additional individual piling. The dolphin is securely wrapped with cable straps and is a very solid structure.

Each of these arms are of such a length as to push off the logs on a skeleton or flat car as the car passes in front of the brow-log. It is a speedy type of jill-poke. The end of each arm is shod with a heavy steel plate that is sharpened so that when it comes in contact with the side of the load of logs it will not slip, and will push the logs over the brow-log into the water.

As the train is being dumped the whirly is controlled by one brakeman who pushes the swinging arms to meet each load, while the other brakeman trips the blocks holding the logs on the car. A trainload of 20 cars is
often dumped in 5 to 7 minutes as compared with 30 minutes or more for dumping a similar trainload by the par-buckle system. There is a minimum of manual labor involved with this system, while the par-buckle system involves a considerable amount of hard work. This is, in itself, an indication that this is an efficient method of log unloading. Figures given by Bloedel, Stewart and Welch indicate that the initial investment in this type of log unloader is less than other types. The cost of the whirly is given as $525.23. Crown Zellerbach gives the cost of the par-buckle system used at Sail River as being close to $4,000.00.

Drawing 3 is a plan of the first whirly built by Bloedel, Stewart and Welch at their Bloedel, B. C., camp on the east coast of Vancouver Island. Since this particular whirly was built, the company has had several constructed at other operations and improvements have resulted. One major change has been in the brow-logs used. As indicated in the drawing the brow-log was formerly constructed of two logs, hewn off and strapped to the deck. These brow logs were usually strapped around with old cable to prevent fraying caused by the logs continuously dumped over them. The new method is to drive a row of fender piling along the outside edge of the dump and cutting them off about 48 inches above the deck. A piece of railroad steel is spiked to the cut-off piling and this acts as protection against brooming which might be caused by the continual dumping of logs on top of the piles. These fender piling act, also, as a protection to the outside piles in the bents beneath the brow-log. This has proved to be more successful and has required less maintenance than the method illustrated in Drawing 3. The whirly, like the par-buckle system, must have deep water if any great volume is to be dumped over the dump at any one time. Plate 14 shows the whirly and a car of logs being unloaded. Plate 15 and 16 show other views of the whirly and the log dump.
OIL TANKS

Wherever steam equipment is used it is necessary to use some sort of fuel for firing the boilers. In probably 95 per cent of all the railroad logging camps in the Northwest this fuel is oil. It has been proved to give greater efficiency, is easier to handle and is much safer during the fire season. A large camp will often use oil for central heating, cook-house stove, skidders, steam track-side units, steam cold-deck machines, and locomotives. Since a large volume is used it is necessary to build large storage tanks so that a month's supply can be bought at one time. It is the construction of these storage tanks with which this paper is primarily interested.

The tank must be constructed near the railroad track so that locomotives can refuel from an overhead pipe and tank cars can be filled in the same manner; and it must also be built fairly near the water so that the oil when brought in by a tanker will not have to be shipped an unreasonable distance. However, it is a wise plan not to build the tank too near the dumping trestle because a fire on either would be apt to spread to the other. It is preferable to build the tank on solid ground for cheapness. If this is not possible, and often it is not, then a structure must be built so that the tank will be elevated and so that gravity will be possible for a feed system. Plates 15 and 16 show the oil tank at Franklin River and this particular tank has a capacity of 10,000 barrels of fuel oil. The two small tanks on the same base are for gasoline and diesel fuel respectively.

The platform of the tank is built of 120 pieces of cedar piling driven very solidly into the sand and the tank was built by a contractor on the ground. If the total weight upon this structure is calculated it is found
to be 4 million pounds, or 2000 tons. Each piling therefore bears a weight of 16\frac{1}{2} tons.

The cost of the stand for these tanks was $1,969.53 and the cost of the large fuel oil tank installed was $5,717.43. The gasoline tank and the diesel oil tank was $790.23. The total initial investment for the tanks was $8,477.19. Here, again, is an indication of good planning. Perhaps the most notable item here strikes one as being the high original investment put into these tanks, but at the time the tank was being built it was found by investigating prices of fuel oil in various sized orders that by combining with another company near by and buying at the same time each month as this company and by building an excessively large tank at Franklin River, that a large saving could be had per barrel of oil in the purchase price. This was due to the policy of the oil companies to give reduced prices with the larger orders. This saving figured over a period of years amounts to a very considerable sum and although the initial cost is high, the saving in the long-run is great. Once again engineering paid dividends.

Grid Irons

A grid iron is an important waterfront structure, since it is the usual practice to bring in freight cars and other rolling stock on scows and to unload these onto the company's own tracks.

Plate 17 shows the grid iron at Franklin River and in this instance it was built on the sand instead of driving the usual five bents of piling, cutting them off and capping them at a level which will allow the scow to rest securely upon them at low tide.

The movable apron at the end of the grid is moved up and down by means of a hand winch and then blocked in the desired position and an idler
is used between the locomotive and the car on the scow to prevent undue weight upon the apron of the grid trestle.

CONCLUSIONS

In conclusion it should be stated that there has been only one objective to this paper and it is hope that that objective has been reached. It has been to impress upon Logging Engineering students that planning is possible in all types of construction. By considering all the facts and by approaching the problem from various angles, often it is possible to cut the cost of the original investment and to cut operating costs by the installation of some advanced method in the operation of unloading or booming.

Two exhibits accompany this conclusion. The first shows what can be accomplished by good planning. Although this estimate is not good in several individual instances, the job as a whole averages out so that a very close estimate was made on the completed job. The second exhibit shows some cost figures for waterfront construction at Franklin River, B. C.

It is hoped that the pictures and drawings accompanying this report have given a clearer idea to the reader than a word description of these structures could have.
## Exhibit 1

**CROWN ZELLEBACH CORPORATION—NEAH BAY DIVISION**

### Estimated and Actual Costs of Construction of Booming Ground at Sail River.

<table>
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<tr>
<th></th>
<th>Estimated Cost 1934</th>
<th>Actual Cost 1934 and 1935</th>
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</thead>
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<tr>
<td><strong>Dredging:</strong></td>
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<tr>
<td>Labor and Materials</td>
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<tr>
<td><strong>Construction of Boom:</strong></td>
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<tr>
<td>Labor</td>
<td></td>
<td></td>
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<tr>
<td>Drive Bulkhead Piling</td>
<td>1,321.88</td>
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<tr>
<td>Drive Dolphin Piling</td>
<td>438.00</td>
<td>379.38</td>
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<td>Drive Trestle Piling</td>
<td>628.00</td>
<td>798.55</td>
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<tr>
<td>Make and Drive Sheet Piling</td>
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<tr>
<td>Place Lumber on Bulkhead</td>
<td>360.00</td>
<td>360.71</td>
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<tr>
<td>Place Bridge Timbers</td>
<td>233.91</td>
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<td>Hew False Caps</td>
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<tr>
<td>Build Upper Dump</td>
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<tr>
<td>Wrap Dolphins</td>
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<td>Build Rock Bulkhead</td>
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<td>Moving</td>
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<tr>
<td>Handle Material</td>
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<td>Shop Labor</td>
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<td>Place Lines</td>
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<td>Deliver Piling (logging)</td>
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<td>Shooting</td>
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<tr>
<td>Stiff Boom</td>
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<tr>
<td>Miscellaneous</td>
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<td><strong>Total</strong></td>
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**Materials:**

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<th>Actual Cost 1934 and 1935</th>
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<td>Lumber</td>
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<td>Hardware</td>
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<td>Powder</td>
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<td>Stumpage</td>
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<td>Brow Log</td>
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<td>Used Wire Rope</td>
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<td>Filling</td>
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<td>Miscellaneous</td>
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<td><strong>Total</strong></td>
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**Miscellaneous:**

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<tr>
<td>Rentals, Towing, Freight</td>
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<td>3,919.85</td>
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<td>Engineering and Overhead</td>
<td>3,200.00</td>
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<td><strong>Total</strong></td>
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**TOTALS**

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<th>Estimated Cost 1934</th>
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<tbody>
<tr>
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<td>$46,784.04</td>
<td>$46,804.85</td>
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Exhibit 2

Bloedel, Stewart and Welch, Ltd., at Franklin River report the following figures for their initial investment at their waterfront at Franklin River. 6

<table>
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<tr>
<th>Description</th>
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<td>Gridiron and Unloading Boom</td>
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<tr>
<td>Gridiron at Sawmill (C.P.R. tracks)</td>
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<tr>
<td>Log Dump and Trestle</td>
<td>$9623.15</td>
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<tr>
<td>Whirly</td>
<td>$525.23</td>
</tr>
<tr>
<td>Oil Tank Stand</td>
<td>$1969.53</td>
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<tr>
<td>Wharf</td>
<td>$1312.02</td>
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<tr>
<td>Fuel Oil Tank</td>
<td>$5717.43</td>
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<tr>
<td>Gasoline and Diesel Tanks</td>
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<tr>
<td>Booming Ground Construction</td>
<td>$4382.91</td>
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<td>Booming Ground Equipment</td>
<td>$1060.91</td>
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<tr>
<td>Boom Tug</td>
<td>$1150.00</td>
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<tr>
<td>Wood Yard</td>
<td>$775.72</td>
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<tr>
<td>Grades around dump</td>
<td>$2593.33</td>
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<tr>
<td>Drilling and Blasting Rock on Grades</td>
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<tr>
<td>Ties</td>
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<tr>
<td>Steel</td>
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<td>Ballast</td>
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<tr>
<td>General Expense</td>
<td>$188.53</td>
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Total Investment: $39,440.44

Cost on 15-year basis: Average Annual Investment $42,400.00

- Interest @ 5%  $2100/year
- Depreciation  2630/year
- Maintenance   1000/year
- Maintenance   5730/year

Annual production--100 million board feet

Cost per M. = $0.057/M
BIBLIOGRAPHY


2. Davis Rafting, The Timberman, November, 1941.


5. Dunham, Charles E., Letter from Bloedel, Stewart and Welch, Ltd., to author, February 2, 1942.

6. Dunham, Charles E., Letter from Bloedel, Stewart and Welch, Ltd., to author, January 6, 1942.


10. Largest Log Raft Enters Fraser River, The Vancouver Daily Province, September 7, 1941.


APPENDIX

AGE

RENEWED BOND

Demanded
Plate 1

A Benson raft, showing heavy binder chains used to hold logs in place.

Note the long logs.
Plate 2

Two Benson rafts in the Columbia River, ready for towing to San Diego. These rafts contain approximately 5 million board feet, each, and have over 120 tons of binder chains, each.
Plate 3

A Davis raft of hemlock in Masset Harbor, Queen Charlotte Islands, British Columbia, ready for transport to Crown Zellerbach Corporation at Ocean Falls, B. C.
Plate 4

A flat boom of large spruce logs at Port Angeles, Washington.
Note the swifter sticks—used in preference to swifter lines.
A bag boom of spruce logs in foreground.
Plate 5

Ponderosa pine logs in a mill pond at Klamath Falls, Oregon. These logs are seldom boomed in a flat boom because storage is not practiced due to the quick discoloration quality of the pine.
Plate 5
A load of Ponderosa pine logs on the Southern Pacific railroad in Klamath Falls, Oregon.

Such loads of logs cannot be dumped by a whirly or log unloading machine as well as by a par-buckle system.
Plate 7

The booming ground at Sail River in the process of construction. All material that could be reached by the drag-line shovel on the bulkhead was thrown behind the bulkhead and all material in the middle of the river was loaded onto scows by the large dredge pictured here.

Note the size of some of the material moved in the right foreground.

Plate 8

Material from the middle of the river was loaded onto centre-dump scows and dumped into the Strait of Juan de Fuca.

Note mainline railroad and highway in background.
Plate 9

The almost-completed booming ground and log dump.

Sail River enters the booming ground in the background and the reported yearly maintenance charge due to silt and gravel deposited by freshets in the wetter months is $5,000.
Plate 10

A par-buckle dump at Euwana Box Company, Klamath Falls, Oregon. This is the usual type of unloading rig for trucks and in eastern Oregon.
Plate II

A simple type of log dump often used for trucks but seldom seen for carload dumping.

This dump is at the Big Lakes Box Company in Klamath Falls, Oregon, and is used for unloading logs brought in over the Southern Pacific.
Plate 12

A log-unloading machine at the Weyerhaeuser Timber Company log dump at Klamath Falls.

Note the double track trestle.
Plate 13

An unusual design of log dump is pictured here, and in place of the usual brow-log the distance from the outside edge of the dump to the outside rail is shortened, thereby dropping the logs into the water without damage to the trestle.
Plate 14

The trestle and log dump at Franklin River, B. C., showing the whirly dumping rig and a load of logs going over the brow-log.

A gin-pole is rigged nearby for use in emergency.
Plate 14
Plate 15

Showing a scow at the grid iron at Franklin River, B. C.

The booming ground can be seen in the background and the large oil fuel oil tank can be seen in the right corner. The small tank is for diesel oil and a similar tank on the other side is used for gasoline.
Plate 16

A view of the oil tanks of Franklin River showing the large fuel oil tank and also the deisel oil and gasoline tanks.
Plate 17

Showing the dumping trestle and whirly dumping machine at Franklin River, B. C.
Drawing 1 shows the boom layout at Bloedel, Stewart and Welch booming ground at Franklin River.

This booming ground is unique because of the fact that it is in such deep water. The contours on this drawing show as much as 300 feet depth. Floating anchors are shown in the lower right corner.

The only replacement cost involved here is that of stiff-leg sticks and chains. The underwater anchor lines, connected to the shore, are kept 8 feet below the water surface by anchors, thus allowing the free movement of logs into the various pockets.
Drawing 2

Drawing 2 shows the track layout and the location of the various waterfront structures at Franklin River, B. C., at the log dump of Bloedel, Stewart and Welch, Ltd.

While the logging was in the Franklin River drainage and the Franklin River Mainline was being used there was no difficulty with adverse grades. Loads were preceded by the locomotive which backed out the tail-track until the end load cleared the switch to the dump trestle. However, when logging was started on the South Mainline it then became necessary to haul the loads over a short stretch of 4½ adverse grade and as a result the Line B was built which is a level line and which allows the same dumping procedure that was practiced from the Franklin River Mainline.
Drawing 3

Drawing 3 shows the Whirly Dumping machine used at Franklin River. This is a very satisfactory piece of equipment and is being used at three large camps of Bloedel, Stewart & Welch at the present time. The cost of construction is reported as being less than $600 and is far superior to the par-buckle system of dumping.
Drawing 4

Drawing 4 shows the plan of the mouth of Sail River prior to 1934 at which time dredging took place and it was turned into a booming ground for Crown Zellerbach Corporation.

The small dotted cross lines indicate the positions at which cross-sections were taken by sound. Volumes were calculated and the dredging was done with this as a basis.

The location of the proposed bulwarks is noted on the drawing.
WASHINGTON PULP & PAPER CORP.
NEAH BAY, WASH.
Proposed Dredging At Sail River Beam
Scale 1" = 50'

Typical Section

Detailed of Bulkhead Driving Plan

Plan of Sheet Pile

Quantities

Limit defined on Plan and Sections

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<th>Bureau / Class</th>
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<th>Quantity / Yd</th>
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<td>5</td>
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<td>30,500</td>
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<tr>
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<td>Solid Rock</td>
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<tr>
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Drawing 5

Drawing 5 shows the mouth of Sail River as it exists today. Dredging took place in 1934 and a small amount has taken place annually since that date to take out the amount deposited by river silt and by the bark dropping off the logs as they are unloaded.

This plan includes the railroad layout and the loading berth layout as well. The chief difficulty encountered seems to be the small space in which to build the Davis rafts that are necessary for the transport of the logs to Port Angeles. The maximum raft that can be built is about 400 M. board feet.
Drawing 6

This drawing shows a cross-section of the log dump at Sail River. This is an old type of dump and more modern dumps are now being built but this is a type that is often seen where trucks are used.