The Willamette River: An Outlet for the Log Resources of the Willamette Valley

by

John R. Gardner

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Approved:

[Signature]
Professor of Forestry
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ACKNOWLEDGEMENT

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INTRODUCTION

For many years, the humming activity of Portland's sawmills and of those of the lower Columbia River was intensified by an abundant and easily available supply of logs for their ponds and booms. Log transportation to the mill was a major cost of the logs for which the mill operators had to pay, and yet this cost did not cause them a great deal of concern because there were then no important problems of distance or availability of logs. The sawmills were well located in these respects, and perhaps more so in regards to the excellent shipping and harbor facilities to which they had access.

In more recent times, however, the sawmill operators in these areas have become increasingly aware of a problem—that of continuing a supply of logs at low prices for their mills to cut. No longer can they reach back of their mills into the surrounding hills and pull out the logs that they need. These sources have been largely cut out or depleted by fire. Now they must fall back on other sources, less available and more distant, if they wish to continue their operations on the same or on a larger scale. Log transportation by rail, and by motor trucking especially, has greatly improved in its efficiency in recent years, it is true, but use of such means would nevertheless prove very costly and in many cases would be prohibitive on these new, comparatively long hauls. The purpose here, therefore, is to show the facilities and development of log transportation on the Willamette River and how this means can supply logs at lower prices to the mills of Portland and the lower Columbia River, which logs are so essential to preserving stability both in industry and in market in this region.
The organization of material to form the text for this paper will include a description of the Willamette Valley, that is, of the timber resources and lumber industry in the valley. As the subject of actual log transportation on the Willamette River is approached, a brief treatise on the early users of the river for such purposes will serve as introductory material. From then on, the actual development will be accompanied by more detailed descriptions of present features of Willamette River log transportation and the problems which confront it. The remainder of the text will deal with probable future development.

The information for this report was chiefly derived from three sources: 1. Personal interview with those who are acquainted with the subject 2. Actual observation 3. Trade and technical publications.
The Willamette Valley

This, the largest and most flourishing valley in the northwest, lies in northwestern Oregon and comprises 11,200 square miles of drainage area, or nearly the area of Holland. The Willamette River flows northward through the center of the valley, which is about 150 miles in length with an average width of about 75 miles, to empty into the Columbia River. Surrounding the entire valley are ranges of hills and mountains of varying elevations. On the west the Coast Range separates it from the Pacific Ocean, on the east the Cascade Mountains form its boundary, the Calapooya Mountains are its southern limit, while at the north is a range of low hills crossing the river at Oregon City, forming the northernmost boundary of the basin. These mountains together are the forest covered sides of a great natural basin.

The slopes of these mountain ranges are steep and rise rather abruptly from the valley floor. Originally, the greatest part of the drainage area was covered with forests, and although much of the valley floor and some of the foothills have been cleared off or burned, the mountain portions to a great extent remain forested. Practically all of the area which now contributes to the flow of streams is within National Forest boundaries. The beneficial influence which the original forest cover exerted on the regulation of stream flow, though modified to some extent by forest fires and lumbering operations, still remains, the water producing portions of the area having been little disturbed (2).

The main stream of the Willamette River takes form in the vicinity of Eugene, Oregon, where the junction of its three main tributaries occurs. These tributaries are the Coast Fork, the Middle Fork, and the Mackenzie River. The Willamette is about 294 miles long from the
source of the Middle Fork to the mouth of the main river. The other chief tributaries are shown in the table below, giving their respective drainage areas. Those in the left hand column have their sources in the Cascade Ranges, while those on the right originate in the Coast Range.

<table>
<thead>
<tr>
<th>Stream</th>
<th>Drainage Area</th>
<th>Stream</th>
<th>Drainage Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Coast Fork</td>
<td>680</td>
<td>Long Tom</td>
<td>410</td>
</tr>
<tr>
<td>Middle Fork</td>
<td>1,350</td>
<td>Mary's</td>
<td>300</td>
</tr>
<tr>
<td>McKenzie</td>
<td>1,320</td>
<td>Luckiamute</td>
<td>310</td>
</tr>
<tr>
<td>Calapooya</td>
<td>370</td>
<td>Rickreall</td>
<td>150</td>
</tr>
<tr>
<td>Santiam</td>
<td>1,840</td>
<td>Yamhill</td>
<td>770</td>
</tr>
<tr>
<td>Molalla</td>
<td>890</td>
<td>Tualatin</td>
<td>710</td>
</tr>
<tr>
<td>Clackamas</td>
<td>930</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>7,380</strong></td>
<td></td>
<td><strong>2,650</strong></td>
</tr>
</tbody>
</table>

*Originates in Calapooya Mts. (Also see map on next page)

Altogether, there are 800 to 900 watercourses, rivers, streams, and creeks, fairly evenly distributed, rendering the valley a perfect drainage basin as far as runoff is concerned (2).

**Log Supply**

Most of the timber of the Willamette Valley now lies on the extensive slopes of the surrounding mountains, particularly on the eastern slopes of the Coast Range and on the western slopes of the Cascades. The 100 billion board feet of timber in the valley represents more than one third of the total volume in western Oregon, approximately one fifth of the total in the Douglas-fir region, and one fifteenth of the nation's total. About half of this timber is in private ownership and half is in public ownership (1).

Except for a small, scattered volume of hardwoods, the forests of the valley are coniferous. Most of the commercial timber (80%) is Douglas-fir with 60% or more of old growth. Among the other coniferous species are Western hemlock (11%), true firs (5%), cedars, and spruce,
which are confined largely to the upper slopes of the Cascades and the higher elevations of the northeast Coast Range. The scattered hardwood stands consist chiefly of maple, cottonwood, and alder, which are found mostly on the lower elevations within the valley (1).

With the exception of small areas in the western part, all of the unit is tributary to the Willamette River.

Log consumers within the valley

The lumber and allied industries have been steadily converging on the vast forests of the Willamette. Today, an increase in the utilization of this great body of timber can be readily detected by the growth in the number of sawmills, plywood plants, and special manufacturing factories which have made appearance within the valley. In observing the characteristics of these industries, a large and gradually expanding lumber industry is disclosed, unique in that the size of the individual mill is relatively small. The plywood industry, of which there was none in 1938, has rapidly grown within the last few years, while the smaller pulp and paper industry has remained stable (4).

More than 10% of the population of the valley is directly supported by wood processing industries, and about 15% in addition depends on service industries for employment.

The wood-using manufacturing industries of the valley, not including Portland and vicinity, are as follows: (1)

- over 300 lumber mills
- 6 plywood plants
- 5 pulp and paper plants
- several furniture factories
- several wood-preserving plants
- box factories
- shingle mills
- insulating board plants
- planing mills
The Willamette Valley's lumber industry is distinctly different from that of other large lumber producing centers in the Douglas-fir region. It is different in this respect; there are very few mills producing more than 100 M board feet of lumber per day, while in other centers such as Puget Sound, Gray's Harbor, and the Columbia River, the bulk of the lumber produced is sawn in mills producing over 200 M board feet per day. A partial explanation for this lies in the fact that the mills of the valley are not within reach of tidewater or waters navigable to oceanic vessels while most of the larger mills in the Douglas-fir region are so located. It is most probable that any expansion in the valley's lumber industry will come through an increase in the number of mills of medium and small capacity (1).

Its plywood industry was not begun until 1939, when the first plant was built at Willamina in Yamhill County. In 1940, five additional plants sprang up at Sweet Home, Springfield, Eugene, Lebanon, and Albany, making a combined capacity for the six plants of 412 million square feet of 3/8", 3 ply panel stock. However, for many years preceding the industry's beginning here, the valley's forests of large yellow fir appeared attractive to plywood men, and a considerable volume of peeler logs has been exported to Portland and Washington plants (1).

The five pulpmills in the unit have a combined capacity of about 1000 tons of pulp per day, their locations being at West Linn, Oregon City, Newberg, Salem, and Lebanon. Hemlock, Spruce, and white fir are the chief species used (1).

Log consumers outside the valley

Since 1933 there has been a steady increase in the number of logs taken out of the Willamette Basin, and although the greater part of these logs are consumed by valley manufactures, a sizeable portion is
shipped to outside points. As an example, in 1939 there were 1,123,000,000 board feet of lumber manufactured in the valley, and with a 15% overrun, it would have taken 977,000,000 board feet of sawlogs to produce this amount. However, there were 1,136,000,000 board feet of sawlogs actually produced, which shows that 86% of the logs were used by valley manufacturers and 14% were shipped outside. The percent shipped out has increased considerably in later years, the greater part being transported on the Willamette River.

Immediately outside of the valley unit is the large manufacturing center of Portland, with its sawmills, furniture factories, plywood plants, box factories, and other wood-using concerns. The entire industry in Portland is becoming increasingly dependent on valley sources for its log supply. The wood-using industry of the lower Columbia River, from Vancouver, Washington, as far as Astoria, Oregon, has found considerable advantage in securing logs from the Willamette Valley for its sawmills, plywood plants, and pulpmills. (The map on the next page shows the general scene at Portland and along the lower Columbia).

In order to present an idea of the size of the lumber industry in this district, the following table is given, showing the lumber production of Portland and lower Columbia River sawmills in 1941 and 1931.
Table II.

Portland-Columbia River Lumber Production

<table>
<thead>
<tr>
<th>Company</th>
<th>1941</th>
<th>1931</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inman-Paulsen Lumber Co.</td>
<td>55,522,000</td>
<td>130,000,000</td>
</tr>
<tr>
<td>Eastern-Western</td>
<td>81,000,000</td>
<td>58,000,000</td>
</tr>
<tr>
<td>Clark-Wilson</td>
<td>171,000,000</td>
<td>195,505,729</td>
</tr>
<tr>
<td>Multnomah Lumber &amp; Box Sales</td>
<td>22,000,000</td>
<td>14,853,261</td>
</tr>
<tr>
<td>S. E. Portland Lumber Co.</td>
<td>22,500,000</td>
<td>16,000,000</td>
</tr>
<tr>
<td>Jones Lumber Company</td>
<td>48,000,000</td>
<td>34,500,000</td>
</tr>
<tr>
<td>Portland Lumber Mills</td>
<td>69,925,000</td>
<td>36,000,000</td>
</tr>
<tr>
<td>West Oregon Lumber Co.</td>
<td>159,014,447</td>
<td>39,000,000</td>
</tr>
<tr>
<td>E. F. Johnson Lumber Co.</td>
<td>25,000,000</td>
<td>19,000,000</td>
</tr>
<tr>
<td>Kingsley Lumber Company</td>
<td>30,000,000</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>689,981,447</td>
<td>538,858,990</td>
</tr>
</tbody>
</table>

Columbia River - Washington

<table>
<thead>
<tr>
<th>Company</th>
<th>1941</th>
<th>1931</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weyerhauser - Longview</td>
<td>400,000,000</td>
<td>219,467,070</td>
</tr>
<tr>
<td>Long Bell - Longview</td>
<td>454,037,058</td>
<td>201,814,177</td>
</tr>
<tr>
<td>Col. R. Paper Mills - Vancouver</td>
<td>34,545,000</td>
<td>22,000,000</td>
</tr>
<tr>
<td>Dubois Lumber Co. - Vancouver</td>
<td>16,500,000</td>
<td>7,559,000</td>
</tr>
<tr>
<td>Dubois-Matlock - Vancouver</td>
<td>9,816,000</td>
<td>8,000,000</td>
</tr>
<tr>
<td>Ostrander - Ostrander</td>
<td>(dismantled)</td>
<td>17,110,836</td>
</tr>
<tr>
<td>Deep River - Knappton</td>
<td>19,900,000</td>
<td>(down)</td>
</tr>
<tr>
<td>Crown-Will. Paper - Cathlamet</td>
<td>18,740,137</td>
<td>--</td>
</tr>
<tr>
<td>Steb Co. - Vancouver</td>
<td>34,804,984</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>988,343,179</td>
<td>475,950,883</td>
</tr>
</tbody>
</table>

*6 1/2 months-destroyed by fire

Columbia River - Oregon

<table>
<thead>
<tr>
<th>Company</th>
<th>1941</th>
<th>1931</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westport - Westport</td>
<td>94,189,155</td>
<td>105,000,000</td>
</tr>
<tr>
<td>Pope &amp; Talbot - St. Helens</td>
<td>131,161,241</td>
<td>96,380,000</td>
</tr>
<tr>
<td>Prouty Lumber &amp; Box - Warrenton</td>
<td>48,000,000</td>
<td>32,000,000</td>
</tr>
<tr>
<td>O'brien-Gram Spruce - Astoria</td>
<td>15,953,000</td>
<td>--</td>
</tr>
<tr>
<td>Van Vleet - Rainier</td>
<td>22,186,798</td>
<td>12,524,000</td>
</tr>
<tr>
<td>Young's Bay - Warrenton</td>
<td>66,504,000</td>
<td>7,520,000</td>
</tr>
<tr>
<td>Wauna - Wauna</td>
<td>46,471,000</td>
<td>(down)</td>
</tr>
<tr>
<td>Bradley-Woodard - Bradwood</td>
<td>29,721,704</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>454,186,898</td>
<td>255,424,000</td>
</tr>
</tbody>
</table>

Grand Total                                  | 2,132,491,524 | 1,272,233,573 |

The districts of Gray's Harbor and Puget Sound have in recent years imported a small volume of logs from the Willamette Valley, chiefly for lumber and plywood mills. The logs from the valley are generally transported by water to points on the lower Columbia, such as Longview, and from here are shipped by railroad to their destination. Some are shipped straight through by rail. Practically all the logs shipped to these districts are Douglas-fir peelers or No. 1 logs.
A small volume of valley logs is exported to other United States points or to foreign countries from Portland, these logs being generally of short length and of high grade.

With this picture of the Willamette Valley, its timber resource, and the industry making use of this resource in mind, we will now turn to a description of the means and methods of log transportation on the Willamette River, without which the present stable conditions of the lumber industry in Portland and on the lower Columbia River would not exist.
Log Transportation on the Upper Willamette River

Since the old "whitewater" days of logging in Maine and Michigan, the transportation of logs by water has been the least expensive means of getting the logs to the mill. When even the largest logs are in the water, one man with a pike pole and peavy can move them with ease, and no expensive heavy machinery and equipment is necessary. And, when the logs are finally dogged or placed in boomstocks to form rafts, one small tug-boat, manned by two men, can handle over three hundred thousand board feet of logs on a downstream tow.

In the late 1800's on the upper Willamette, the first towboats were the "Topsy" owned by Ed Dove of Corvallis and the "Isabell" owned by J. L. Smith of Salem, both being stern-wheeled steamers. These boats hauled odd freight and some logs, and were probably the first log tow-boats on the upper river. About this time, the Prather Brothers, the first to handlog the Willamette, from their booming ground at the mouth of the Luckiamute drove their fir logs in rafts to Salem, about 25 miles downstream. By means of sweeps, which are long-handled steering oars, they could handle the raft without many tie-ups. Yet this means did not prove altogether satisfactory, and so the "Gray Eagle", another log tow-boat, was built in 1894. Owned by the Spaulding Lumber Company, it was used to tow pulpwood logs of cottonwood and white fir from Harrisburg to Oregon City. In 1902 the Spaulding Company acquired another boat, "The City of Eugene", which towed sawlogs to Spaulding's Salem mill and pulp timber to Oregon City. In 1900, a log drive, beginning about the first of June and ending in September, was made from the Mackenzie River to Newberg, and during this period from five to nine million board feet of pulp logs were driven down the river. Drives, consisting entirely of pulpwood, continued until about 1915. The Doernbecher Manufacturing Company has rafted cottonwood and maple logs.
downstream for the past 35 years. They obtained most of their logs directly from the river banks in the earlier days, and rafting downstream was the only form of transportation necessary (9).

The period between 1920 and 1935 saw no great changes on the upper river. Steady but small log volumes were handled, and an improved type of towing craft for the upper Willamette waters was found in small, gasoline-powered tugs with a very light draught. From 1935 to 1939 the log movement down the river and through the locks at Oregon City was gaining at a steady rate. Then suddenly, in 1939, this movement experienced a great increase. Coming as it did, this increase, which is still in progress today, was a phenomenal change, and it will probably be marked as one of the noteworthy features in the annals of Oregon's log movement. It has suddenly opened up log dumps and booms along the banks of the upper Willamette from Oregon City to Albany. It has made necessary a fleet of powerful and fast tug-boats in these waters. The locks at Oregon City have been swamped with log traffic, and improvements and even plans for new locks have been made. Navigation has been improved all along the upper river. Greater efficiency in trucking equipment, along with improved highways and secondary roads has made possible long-distance hauls from outlying points to the river. The new market for Willamette Valley logs at Portland and the lower Columbia had come into existence. It is now a common sight to see great masses of Willamette Valley log rafts tied along the river banks at Portland, waiting to be scaled and towed to the sawmill.

Many years before this new source of supply was thought of, Portland's mills and those on the lower Columbia secured virtually all their logs from points below the mouth of the Willamette River along the Columbia. From Deep River to Vancouver on the Washington side
and from Young's Bay to Scappoose on the Oregon side logs were dumped into the Columbia from a number of railroad operations. Most of these operations have passed from the scene since that time. Then logs began to come in increasing quantities to the Columbia from the Tillamook country, where operations continued until the great Tillamook fire in 1933. However, there is still a considerable volume of logs on the Columbia River log market from salvage operations on the burn. In more recent years, some logs have come into this market from the mid-Columbia section, chiefly from Vancouver to Wind River on the Washington side. Yet the decline in these sections was realized, and the need for logs to keep the wood-using industries of Portland and the lower Columbia running was the cause of many glances directed toward the Willamette Valley (5).

Early in 1938 the Charles K. Spaulding Company rafted logs to go through the locks at Oregon City to the lower Willamette. This company was one of the first commercial loggers to add its volume to the present movement of logs. In 1939 new logging concerns began to make use of a few dumps along the river, and today these concerns range from small, one-side camps with light equipment and a few trucks to companies with from two to five sides with heavy equipment and a fleet of trucks.

Nearly all the logs pouring into the Willamette above Oregon City arrive at the dumps by truck, excepting by one or two rail hauls. Logs trucked from points on the Coast Range as far as 70 miles have been dumped into the upper Willamette to be rafted and towed to Portland and Columbia River mills. Log transportation by water, the oldest method known, and transportation by truck, the most modern method, have been teamed together to open up the Willamette Basin (3).
Dumps and booms to accommodate trucks hauling logs have been established from Oregon City to Eugene. However, the greatest volumes enter the river between Canby, just above Oregon City, and Albany. In traveling upstream from Oregon City by boat, one first notices Canby with its four large dumps, these taking in a sizeable volume from the Molalla River country. In about 15 miles Newberg is reached, where one large dump is in operation, taking in logs from the Coast Range. Coming in just above Newberg is the Yamhill River, the only navigable tributary to the Willamette, and four or five small log dumps are located along its banks at Lafayette and Dayton, handling logs from the Coast Range. There are no more dumping grounds on the Willamette until Salem is reached, a distance of about 35 miles, and here logs arrive at four dumps from both the Coast and Cascade Ranges. About 10 miles above Salem at Independence, logs from the Coast Range pour in to a large dump, and between here and Albany, about 25 miles distance, there is no activity. At Albany, four dumps accommodate a large volume from the Cascades and Coast Ranges and above this point, the log traffic is chiefly hardwoods and pulpwood.

The Doernbecher Manufacturing Company is the chief user of the river above Albany, and today most of their cottonwood and maple holdings are back from the river or along its unnavigable tributaries. A truck haul is required to bring logs to its Willamette River dumps, which are scattered, as can be seen on the map on the following page. Doernbecher's longest tow is 120 miles, to its plant at Coalca from Young's Island, which, incidentally, is the longest tow made on the upper river (6).

On the page following the map is a chart (Table III) showing the volume of logs handled in the years 1939-1940 by the major log dumps contributing to log traffic on the Willamette. (Note the variations in volume from month to month, due to heavy rainfalls and other conditions slowing up logging and towing.)
This map gives some idea of the large number of truck logging camps which are dumping their logs into the Willamette River, showing the location of some of the major log dumps. It gives some idea of the truck haul involved and the number of trucks in use. There are many others operating in this region.
14.

Table III

Comparison of Origin of Logs Passing Downstream through Willamette Falls Locks, 1939-1940

<table>
<thead>
<tr>
<th>Month</th>
<th>Total</th>
<th>Pulp Siding</th>
<th>Willamette</th>
<th>New Era</th>
<th>Canbyville</th>
<th>New Wilson</th>
<th>New Dun</th>
<th>Day-Lander</th>
<th>Beaverton</th>
<th>Dayton</th>
<th>Fayette</th>
<th>Salem</th>
<th>Corvallis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>12,248</td>
<td>3,800</td>
<td>75</td>
<td>1,700</td>
<td>1,450</td>
<td>1,762</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb.</td>
<td>7,248</td>
<td>3,000</td>
<td>30</td>
<td>1,800</td>
<td>980</td>
<td>2,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar.</td>
<td>6,075</td>
<td>4,000</td>
<td>30</td>
<td>1,920</td>
<td>2,000</td>
<td>1,430</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr.</td>
<td>9,100</td>
<td>500</td>
<td>80</td>
<td>2,800</td>
<td>2,600</td>
<td>3,320</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>11,795</td>
<td>10</td>
<td>80</td>
<td>4,200</td>
<td>4,335</td>
<td>3,455</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>June</td>
<td>7,300</td>
<td>2,200</td>
<td>30</td>
<td>1,700</td>
<td>1,600</td>
<td>1,800</td>
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<td></td>
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</tr>
<tr>
<td>July</td>
<td>5,500</td>
<td>3,500</td>
<td>30</td>
<td>1,500</td>
<td>1,400</td>
<td>1,500</td>
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<tr>
<td>Aug.</td>
<td>2,625</td>
<td>8,800</td>
<td>560</td>
<td>1,200</td>
<td>1,500</td>
<td>1,500</td>
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<tr>
<td>Sept.</td>
<td>18,800</td>
<td>6,675</td>
<td>520</td>
<td>1,000</td>
<td>1,200</td>
<td>1,200</td>
<td></td>
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<tr>
<td>Oct.</td>
<td>4,620</td>
<td>3,620</td>
<td>30</td>
<td>1,200</td>
<td>1,300</td>
<td>1,300</td>
<td></td>
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<tr>
<td>Nov.</td>
<td>11,580</td>
<td>7,700</td>
<td>360</td>
<td>1,000</td>
<td>1,100</td>
<td>1,100</td>
<td></td>
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<tr>
<td>Dec.</td>
<td>10,000</td>
<td>3,800</td>
<td>30</td>
<td>1,200</td>
<td>1,200</td>
<td>1,300</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total 1939</td>
<td>142,110</td>
<td>14,275</td>
<td>500</td>
<td>41,910</td>
<td>37,240</td>
<td>32,320</td>
<td>2,228</td>
<td>54,910</td>
<td>60,600</td>
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<tr>
<td>Total 1940</td>
<td>266,738</td>
<td>22,900</td>
<td>570</td>
<td>38,260</td>
<td>40,960</td>
<td>23,940</td>
<td>13,115</td>
<td>52,125</td>
<td>47,105</td>
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As the trucks bring in their loads from the camps to the log dumps and pull alongside the brow log just at the top of the incline leading to the water, the logs are ready to begin their journey down the Willamette River. The incline is faced with logs, which may either be built out from the bank on piling (fig. 1) or may be fastened directly on the slope (fig. 2). A gasoline unloader with an "A" frame tilts the load toward the river until the logs roll with their own momentum and hit the water. Unless the water is kept sufficiently deep at the base of the incline, both the heavier and butt logs will "hang-up" on the bottom.
Just a few hundred feet downstream from the dump is located the booming grounds (see fig. 3). Logs freshly dumped are sorted here by species and brand, the latter term referring to the mark or symbol stamped on the ends of the logs to designate the owner. After being sorted, the logs are fed into rafting forms (fig. 3) as soon as possible so that log congestion can be prevented. Here the rafts are made up, the logs being fastened together by means of "doglines", which are wire ropes stretched across each row of logs and fastened to each log by "dogs" (see fig. 4). (Boomsticks are not used for rafting until the logs reach the lower river because the sticks would add to the width going through the locks at Oregon City). The dogs are driven into each log, with the dogline threaded through the eye, thus holding the raft together. Above Newberg, where swifter water prevails, logs are often dogged twice each to further insure against breakage of the raft, the extra dogs and lines being removed when Newberg is reached.

After the rafts have been completed at the boom, they are tied a few hundred yards downstream to await towing. Sometimes the rafts are scaled at this point, but generally scaling is done on the lower river.

Each raft on the upper river is from 1000 to 1500 feet in length, about 34 feet in width, and contains 350,000 board feet of logs on the average. Because it is necessary for these rafts to pass through four 36 x 175 foot lock units at Oregon City, they are built in sections, called lockages. Lockages are 34 feet wide and average four log lengths or 160 feet in length, there being from six to eight lockages in a raft. When the locks are reached, each lockage must be separated from the main raft and taken through alone. On the lower side of the locks, the rafts are again assembled (10). (Fig. 5)
Figure 3

Figure 4

Figure 5

(Locks in lower portion of figure)
This same system is used for logs entering the Yamhill River seven miles above its mouth where a single unit lock with dimensions similar to those of Oregon City's exist (fig. 6).

Rafting of hardwoods and pulpwood, especially between Albany and Eugene, differs from these methods of rafting, in that the logs, instead of going downstream lengthwise, are lined side by side and are brought down the river lying crosswise to the direction of the tow (6).

In order to handle the business of towing the large flat rafts in the shallow water of the upper Willamette, from twenty to twenty-five powerful tugs lend their services. These boats are from thirty to forty feet long, are gasoline- or diesel-powered, and draw only about two and one half feet of water, most of them being designed for Willamette River log work. One company, the Bernert Brothers of Willamette, Oregon, own about half of these boats (fig. 7).

The power necessary for a tug in these waters is from 125 to 175 H. P., and this largely limits the size of the raft which can be towed downstream. It is of great importance that the tug have sufficient power to exert a steady pull on the raft, for otherwise the 1000 ft. tail of logs might easily be pulled out of line by the current and "hang-up" on the river banks. Sometimes it is more convenient to handle larger rafts with two tugs, one being at the stern of the raft to help control it. Only the more skilled pilots are able to handle the stern end of a large raft (11).

Each tug is manned by a captain and his deckhand, the latter of whom dogs rafts for towing and has general duties on board. The captain must be experienced and know the waters of the river well with respect to channels, bars, and currents. Some of the more experienced men can actually "read the water" for evidence of good or bad channels.
As was shown before, the locks at Oregon City are the chief reason for the type of rafts built on the upper Willamette. The locks, built in 1873 by private enterprise, were run as a toll concession until 1915, when the War Department took them over. From that time there has been no charge for logs passing through them. Log traffic through the locks was relatively unimportant up to 1938, but in 1939 there was a seven-fold increase in the amount of logs handled, and this amount has been increasing ever since. This increase, in addition to other types of traffic through the locks, has necessitated a 24-hour running time per day, and three eight-hour work shifts keep the operation continuous. As most of the gates at the locks are hand-operated, one lockage of from forty to fifty thousand board feet requires about forty minutes to drop to the lower level through the four lock units. However, two or three lockages can be going through at the same time, each in a different lock unit, thus cutting down the aggregate time for an entire raft.

After the lockages have reached the bottom level of the locks, they are again assembled into rafts which may be of greater length and width than of those on the upper river. Larger and more powerful tugs are employed here to tow the rafts to other booms and storage grounds above and below Portland. (See map on page 8a. for locations). Many millions of board feet of logs are stored at a time for use of mills in the district.

As selling and buying of logs at these locations gets under way, scaling of the rafts is handled almost entirely by the Columbia River Scaling Bureau. The Bureau employs competent scalers, whose scale for the raft is usually accepted as satisfactory by both buyer and seller, and much disagreement is avoided as the scaler is independent of either of these parties. The buyer and seller both
pay the Bureau a share of the scaling expenses. In addition, the Bureau keeps complete records of transactions, which are valuable in many respects to stumpage owners, loggers, sawmill owners, boom operators, and tugboat companies. Having been established during the early days of logging on the Columbia River, the Bureau is directed by active logging and mill operators who are most familiar with conditions in the district. The importance of uniformity has been stressed by the Bureau, and today it is an efficient system for handling the logs on their last lap to the mill (8).
Present Problems of Log Transportation

Since the increased log movement has set in on the upper Willamette, a serious bottleneck to a steady flow to the lower has presented itself. This bottleneck is at the locks at Oregon City. Many times during the year rafts back up the river for over a mile to await their turn to make use of the locks. Many have to wait for days at a time. In 1938, 21,000,000 board feet of logs passed through the locks from upper river points. In 1941, 415,000,000 board feet of logs passed through. Obviously the locks, which were originally built for a small to medium traffic, could not meet such a great increase with efficiency. The hand-operated gates and the four lock units through which each lockage has to progress slows up the movement too greatly, even though operation has continued steadily day and night.

Navigation on the upper Willamette has been greatly handicapped by the shallowness of its bed and by season irregularity of flow. During summer months when the volume of water is low, much difficulty is encountered in keeping rafts off bars and rocks on the downstream tow. At times towing must be stopped altogether. In the other extreme, there is considerable danger of losing control of rafts during high water periods due to sudden spring and winter freshets. Towing is hazardous and rafts must be securely dogged and tied to avoid any mishap. The force of the rushing water in these freshets also dislodges rocks and gravel on the river's bed and fills up channels which are so necessary during low water.
Future Developments on the River

The United States Army Engineers have long recognized the desirability of improved navigation on the Willamette River, and this, with flood control, power development, irrigation, and the reduction of stream pollution has motivated the development of the Willamette Valley Project.

The project, in short, will be to provide for (1) construction of seven reservoirs for regulation of stream flow (2) improvement of the navigable channel between Oregon City and Albany (3) reconstruction of the locks passing navigation around Willamette Falls at Oregon City.

So far, only sufficient funds have been authorized to complete the construction of three dams--The Fern Ridge Dam on the Long Tom River, The Cottage Grove Dam on the Coast Fork of the Willamette River, and Dorena Dam on Row River. No actual construction will commence on the other dams until additional funds have been appropriated by Congress.

When the seven reservoirs are formed behind these dams, they will store a great deal of the flood flows from Willamette River tributaries, offering much more control over the often destructive flood waters than was previously possible. Below is a table showing the seven dams, the streams on which they are located, and the storage capacity of each reservoir.

Table IV

<table>
<thead>
<tr>
<th>Name of Dam</th>
<th>Name of Stream</th>
<th>Storage in Acre Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottage Grove</td>
<td>Coast Fk. Will. River</td>
<td>30,000</td>
</tr>
<tr>
<td>Dorena</td>
<td>Row River</td>
<td>70,000</td>
</tr>
<tr>
<td>Fern Ridge</td>
<td>Long Tom River</td>
<td>95,000</td>
</tr>
<tr>
<td>Lookout Point</td>
<td>Middle Fk. Will. R.</td>
<td>340,000</td>
</tr>
<tr>
<td>Quartz Creek</td>
<td>Mackenzie River</td>
<td>335,000</td>
</tr>
<tr>
<td>Sweet Home</td>
<td>South Santiam River</td>
<td>310,000</td>
</tr>
<tr>
<td>Detroit</td>
<td>North Santiam River</td>
<td>165,000</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1,345,000</td>
</tr>
</tbody>
</table>
Today the U. S. Army Engineers are maintaining a channel from Oregon City to Albany about 150 feet wide and $3\frac{1}{2}$ feet deep. The adopted project for the Willamette Valley includes further improvement of this channel for navigation, which, together with the increased low water flow made possible by the release of water from the storage reservoirs, will provide a channel 150 feet wide and 6 feet deep between Oregon City and Salem and 150 feet by 5 feet between Salem and Albany. The improvement will involve removal of rocks, boulders, and gravel bars in this stretch of the river.

The new project at Oregon City for replacement of the obsolete lock facilities calls for a single lift lock 400 feet by 56 feet in the clear, which will allow lockages over twice the present size to pass through. In addition, only one lock unit will be needed, which in itself will greatly reduce the time required to reach the lower river level. Further cutting down the time required for passage will be the replacement of hand-operated gates and valves by electrically operated equipment. The new lock will cost about $2,500,000, according to present estimate, and it will be sufficiently large to handle future log traffic.

Completion of the Willamette Valley Project will probably extend over a period of from 6 to 10 years, and in many ways it will greatly facilitate development of the Willamette Valley (2).
Conclusion

It seems quite evident that there will be no future expansion in the lumber industry at Portland or on the lower Columbia River, and unless the existing mills here can get more logs from the Willamette Valley, the possibility of discontinuance of operation is in sight for many of them. The Willamette River as a means of log transportation has kept a number of mills, in Portland especially, in smooth running, whether these mills are cutting for grade or volume.

So, no great or sudden increase in log volume is expected to again move down the Willamette in future years. Instead, there is probability of a more or less steady flow by the time the planned improvements for navigation have been completed. Also in consequence of the planned river development will be increased value of that stumpage within reach of river transportation. However, the lumber industry is more likely to converge on the Willamette Valley, than is the valley to send out increasing volumes of logs for long distances to the industry.
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