THESIS

on

A Study of Logging Operations in the Douglas Fir Type.

Submitted to the Faculty of the

OREGON AGRICULTURAL COLLEGE

for the degree of Bachelor of Science by

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Approved.

Dep't. of

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A STUDY OF LOGGING OPERATIONS IN THE DOUGLAS FIR TYPE.

The region under consideration is the valley of the lower Columbia, extending from the Willamette River to the Pacific Ocean. The timber produced is Douglas Fir of average quality, of both the red and yellow forms. The annual cut in this region is approximately 700,000,000 feet, with a value of $5,250,000. This is utilized for all purposes for which fir can be used, including construction, boat building, piles, ties, fencing, and finishing.

The first cuttings were made by the pioneers in the early days, who hewed and sawed by hand such timbers and boards as were necessary to supply their needs. It was not however, until about 1860, that the first sawmill was put into operation near Astoria, Oregon. Since that time, the lumbering industry in this region has grown with remarkable rapidity, with prospects of a much increased growth within the next few years.

In the past, this region has furnished logs to all of the mills along the Columbia, and to the greater part of those of Portland. The same is being done at present, and will probably continue as long as the supply of timber lasts. Although, at the present rate of utilization, the supply is large enough to last for twenty or thirty years to come, the supply is rapidly decreasing, and steps will have to be taken to perpetuate the forests of the region.

In this region, the timber lands are mostly held by
corporate interests, though there are some smaller tracts which are the property of private concerns.

In general, this region consists of numerous rough hills, drained by many small streams. It is covered with a fairly thick virgin growth of Douglas Fir of good quality intermixed with some Western Red Cedar and Western Hemlock. The average diameter of the fir is about 36 inches, while the average age of the same is about 125 years.

As to stand, the maximum varies from 80 M to 90 M board feet per acre, while the average stand is from 45 M to 60 M feet per acre. Estimating on a basis of 50 M feet per acre, and on $2.75, the present price of stumpage per M, the timbered land is worth approximately $150.00 per acre. Of course the price of stumpage decreases with a poorer quality of timber, and also is lower where it is very difficult to log.

Forestry, in the broad sense of the term, is hardly practicable in this region, as the land is more valuable for agricultural purposes than for forest growth. In consequence the attitude of the owner in most cases is such that no forestry practices are followed.

The particular tract under consideration comprises about 10,000 acres, the original cost being $85.00 per acre.

A good idea of the silvicultural conditions there existing may be gained from the following forest description
FOREST DESCRIPTION.

SITUATION,- Six miles west of Nehalem Junction, Oregon.

FOREST TYPE,- Douglas Fir.

ALTITUDE,- Absolute, 540 ft. Relative, 500 ft. above the Columbia River at Nehalem Junction.

SLOPE,- Averages 12°. Aspect, easterly.

ROCK,- Not abundant as a whole. Great outcrops of igneous rock along the Columbia.

SOIL,- Deep, moist, loose clay.

HUMUS,- Deep, of decayed twigs, needles, leaves, cones, etc.

LITTER,- Abundant, of twigs, cones, branches, etc.

GROUND COVER,- Heavy, of Oxalis, grasses, ferns, moss, etc.

BRUSH,- Undergrowth heavy, consisting of vine maple, salal, dogwood, Arbutus, hazel, salmon berry, and thimble berry.

REPRODUCTION,- Poor, of Douglas Fir.

SPECIES IN MIXTURE,- Douglas Fir, Western Hemlock, Western Red Cedar.

DENSITY,- About .7

QUALITY OF LOCALITY,- No.1 for Douglas Fir.

DAMAGE,- No recent damage from fire. None from lightning insects or wind. Many of the trees are affected with fungi, causing punky timber and decaying the hearts of many of the trees at the butts.
Much of the fir is past maturity, and for this reason it is advisable to log the most of it as soon as possible. The hemlock is for the most part rather small, being of no commercial value. What cedar is found on the tract grows along the streams. It is cut, but is so scarce as to hardly be taken into consideration in estimating. The stand is of about the following composition - 95% fir, 3% cedar, and 2% hemlock.

The cut over land is a veritable waste, covered with undergrowth, high stumps, brush, and culled trees. As few trees are left which can produce seed, and as fire is apt to sweep over the land in the dry season, the possibility of reproduction is not good. What few smaller trees are left are for the most part badly injured through the effects of steam logging.

The average stand of fir on the tract is about 50 M board feet per acre, worth at present $2.75 per M. The amount of cedar and hemlock of merchantable size is so small as to be wholly disregarded.

Lumbering operations have been carried on in this tract for about 10 years, and there is still enough standing timber to supply the company with logs for at least 30 years more, at the present rate of utilization. The present method of lumbering, though destructive to the eye of the forester, is conservative in the view of the mill owner, for the stumps are cut as low as possible, the trees are worked up to a small top diameter limit, and nearly everything which will make saw timber is taken. In general, it may be said that the utilization is quite close.
The practice of forestry is hardly to be recommended on this tract as the land is more valuable for agriculture than for forest purposes. Of course on some of the rougher ground and on the higher ridges a forest cover would be preferable. This would be the most easily perpetuated by the leaving of sufficient seed trees, and by clearing the cut over ground by fire. This would remove all brush and debris and give the young growth a chance to start.

In practice, the tract is being logged with no reference to a future supply, and forestry methods are wholly disregarded.

The fire danger in this region is very great during the dry season, beginning in June and lasting until the beginning of the fall rains. Fire is the most likely to start in the cut over sections, due to the presence of much brush, tops, and rotten logs which become like so much tinder during the dry weather. Left without control, the danger of it spreading into the standing timber is very great.

To guard against the accidental setting of fire, all donkey engines and locomotives operating within the tract are fitted with gauze spark arrestors of a fine enough mesh to be effective. The locomotives are also provided with hose to be used in case of necessity. Small creeks are dammed to hold a reserve of water, and buckets and cans are placed along the tracks to be used in extinguishing incipient blazes. Fire lines are established only when necessity compels it, in order to check an advancing fire.
The best means of protection would be to clear the cut over ground of brush and dead timber by fire, especially along the railroad tracks and around the donkey settings. This would prevent to a great extent the beginning of fires. A patrol should be established throughout the forest during the danger season whose duty should be to discover and extinguish small fires.

The boundaries of the tract are marked by the monuments of the original survey, for the most part, squared posts with witness trees. Outside lines are brushed out in order to facilitate re-running them, and also in a measure to prevent trespass.

The lumbering concern consists of the Clark & Wilson Lumber Co., and the Columbia Timber Co., two corporate concerns of the same membership but of different percentages of ownership. Each concern consists of four members.

Four of the members are the active heads of the different branches of the business, namely—Mr. O. M. Clark, in charge of financial affairs, Mr. J. A. Wilson, handling cruising and logging, Mr. C. G. Wilson, superintending milling operations, and Mr. W. W. Clark, in charge of office work.

The main office of the company is at Linnton, Oregon, with a branch office at Goble, Oregon.

This company is connected with the Oregon and Washington Lumber Manufacturers' Association, an organization, the purpose of which is to promote uniformity in the grade of lumber produced in the Northwest.
As logs are now worth about $7.50 per M in the boom, and the amount cut in this camp, approximately 30 million feet per year, the value of the annual output is about $150,000. Usually, however, the price of logs is somewhat higher than this, which would make the above value about $200,000.

The lumber obtained, is used for all purposes of construction, ties, fencing, and in fact for all purposes for which fir can be used. The most important grades of lumber produced are worth per M as follows,— export and select, $15.00 and up; no. 1 common, $8.00 to $12.00; no. 2 common, $6.00 to $7.00.

The lumber is manufactured at Linnton, Oregon, from where it is shipped by boat to ports mostly in Australia, California, and in the Orient. The cost of transportation by this manner is governed by the current charter rates of the various steamship lines involved. There are a few shipments by rail to the interior, in which case the cost of transportation is born by the purchaser.
A preliminary step in planning logging operations is a thorough cruising of the tract under consideration. The cruising of this company is done by Mr. J. A. Wilson, who uses the following method. One section is cruised at a time, using sub-divisions of 40 acres. Beginning at the SW corner of the forty in the SW corner of the section, he paces east 20 rods on the section line. He then turns and paces north 20 rods, bringing him to the centre of a 10 acre plot, or a quarter of the forty. Standing here, he estimates the stand on the plot, counting the trees where the stand is light, and making a lump estimate where the stand is heavy. From this point, he then paces north 40 rods, bringing him to the centre of the next 10 acre plot. This is repeated, going east 40 rods and then south forty rods, bringing him to the centres of the other two 10 acre plots. Each of these is estimated from the central point.

The estimate by the cruiser usually falls considerably under the true amount of timber on the tract, sometimes as much as 20%.

The plan of this company in the purchase of timber lands is to estimate the entire area. This is usually done by a single man, who takes on the average about three days to estimate a section. The cruiser provides himself with a compass, estimate book, and a blue print of the tract. Fairly heavy clothes are worn, with light cruising cutters. Enough bacon, flour, tea, and baking powder are taken to last
during the time in the field, and these, with blankets, a frying pan and a couple of small buckets, in a pack sack, make the equipment required.

The wages of the cruiser are $7.00 per day, with about $0.50 extra per day for food. This makes the cost of cruising about $22.00 per section.

In locating the logging units, preliminary plans were laid at the first cruising for the purchase of the land. This took into consideration the possible outlets for logging roads, prospective camp sites, and the area to be included in each unit. There are about two and one half sections in the present logging unit, this size being determined by the lay of the ground.

About two months before the occupancy of a unit, complete plans are laid for the logging railroad, camp, rollways, and settings. In the establishment of the railroad the grade and distances are determined by leveling and pacing. The lines are run by compass, and stakes are driven to grade in the centre of the proposed road way. The location of roll ways is determined by the lay of the ground and the amount of timber which can be brought to it. Camp sites must be fairly level, and must be where water can be easily obtained.

In making estimates, the cost of the various parts of the logging operation is a secondary matter. Of course, the cost should be consistent with the amount and value of the timber which can be obtained.
If the camp is centrally located, the logging unit may include two or three sections, if other conditions are favorable. The most important factors which govern the size of logging units are topographical features such as streams, ridges, and valleys.

As before stated, the water supply is one of the most important factors governing camp sites. In the camp in question, the water is furnished by a small stream and one spring. The water for the cook house is piped down from a small stream on higher ground above the camp. Water for the locomotives is taken from streams, and is conveyed by gravity to two tanks along the road. Three of the donkey engines in the woods are supplied with water pumped by a gasoline engine from a stream in the hills. The others are supplied through gravity from springs.

The camp is almost centrally located with reference to the logging unit in which it lies, being on a spur, which several years ago was the main line of the logging railroad in the woods. As the engines pass through the camp several times daily, the matter of bringing in supplies is very simple.

The camp lies in the centre of the cleared area, which is still in the same condition as it was left after logging. No attempt is made to clear the camp site of stumps, and the brush is only cleared away around the buildings and for paths. The camp site occupies roughly three or four acres in a narrow strip along the track.
The buildings necessary for a camp of this description are the cook house, bunk houses, blacksmith shop, engine shed, office and tool house. There are numerous other small buildings which are used for various purposes, such as oil house, sand shed, small bunk houses and toilets. The superintendent and foreman each have a small frame house, in which they live separate from the rest of the crew.

At present, the crew which lives at the camp numbers about eighty-five men. The cook house, which is large enough to accommodate ninety men is 26' x 50', including both kitchen and mess room, with several smaller wings.

The bunk houses which are five in number are 10' x 30' each accommodate twelve men. As these house only sixty out of eighty-five men, the remainder sleep in several other small or cabins, and in a wing of the cook house.

The buildings are all constructed of rough lumber, and fitted with doors and windows. All of them have shingled roofs except the bunk houses which are roofed with tar or mineral paper.

The cook house could be built by two men in one week and should not cost over $75.00. The five bunk houses could be built with ease by three men in ten days. At the most, they would be worth $25.00 each.

The blacksmith shop is a building about 30' x 30', with a smaller wing used as a machine shop. The locomotive shed which is connected with it is only a framework covered with a shake roof.
The material used in the construction of most of these buildings was brought in from the company's mill, thus making their cost quite low. When the camp is moved, the smaller buildings will be skidded onto flat cars, and carried to the new camp site. The larger ones will have to be torn down and then re-constructed.

The bunk houses are all heated by means of ordinary box stoves, costing about $7.00 each. There is one in each building, which, with one in the mess room and one in the office, make about twelve in all. The range in the kitchen is 3' x 8', with two large ovens and a water heater, large enough to cook on for one hundred men. Its initial cost was $265.00. The cooking and mess outfit is large enough for the serving of at least ninety men, and is made up as follows,

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>coffee urn</td>
<td>1</td>
<td>lunch buckets</td>
<td>30</td>
</tr>
<tr>
<td>dish pans</td>
<td>6</td>
<td>Gem pans</td>
<td>20</td>
</tr>
<tr>
<td>large pots</td>
<td>8</td>
<td>Granite dishes</td>
<td>50</td>
</tr>
<tr>
<td>cans</td>
<td>5</td>
<td>Water buckets</td>
<td>5</td>
</tr>
<tr>
<td>coffee grinder</td>
<td>1</td>
<td>Plates</td>
<td>90</td>
</tr>
<tr>
<td>large bake pans</td>
<td>6</td>
<td>Saucers</td>
<td>90</td>
</tr>
<tr>
<td>small bake pans</td>
<td>4</td>
<td>Soup plates</td>
<td>90</td>
</tr>
<tr>
<td>pitchers</td>
<td>30</td>
<td>Cups</td>
<td>90</td>
</tr>
<tr>
<td>coffee pots</td>
<td>30</td>
<td>Platters</td>
<td>30</td>
</tr>
<tr>
<td>tea pots</td>
<td>20</td>
<td>Basins</td>
<td>10</td>
</tr>
<tr>
<td>pie tins</td>
<td>50</td>
<td>Tureens</td>
<td>80</td>
</tr>
<tr>
<td>sirups</td>
<td>20</td>
<td>Bowls</td>
<td>50</td>
</tr>
</tbody>
</table>
There are other small articles which are not enumerated. Nearly all of this equipment is of granite iron ware, no china being used. The entire kitchen and mess outfit exclusive of the range is worth about $300.00.

The furniture of the cook house consists of wooden benches and rough wooden tables covered with oil-cloth. The furniture of the bunk houses are bunks 3' x 6', built two deep, as in a Pullman car. These are made of rough boards and are fitted with springs and cheap mattresses. A few of the smaller bunk houses have bed-steads instead of bunks. Seats consist of benches and boxes in all cases.

No arrangements are made for bathing and washing clothes in this camp, other than having access to a small stream near by. Sanitary conditions are fair, as the toilets are all on lower ground than the camp, and all slops are conducted away from the cook house by a small stream.

The camp store, which is a necessary adjunct to every logging camp, is kept in combination with the office. Many necessities which the loggers have occasion to use are kept here, among which may be mentioned the following,

- shoes
- blankets
- tobacco
- underwear
- socks
- candles
oil  cigars
soap   lamps
matches  handkerchiefs
suspenders  gloves
overalls  slickers
pipes  medicines
paper  pens

In a camp of this size, the value of the stores kept on hand is about $450.00. These things are sold to the men at prices which are very much the same as those outside, and are either payed for direct, or charged against the buyer's monthly time. Double entry is used in this system of both cash and credit sales.

The shops are completely fitted for all manner of work, from saw filing, to making locomotive repairs. The equipment is as follows,

blower and forge  3 vices
anvil  tongs
hammers  drills
tool handles  taps and dies
emery wheels  lathe
files  carpenters tools

The lathe is valued at $350.00, while the rest of the equipment is worth about $150.00. To this may be added $200.00 worth of iron and steel, making the total outlay for the shops about $600.00.

All of the repairs to the locomotives, donkeys, chains, and other equipment are made here.
Other miscellaneous equipment, not counting the locomotives and the donkeys in the woods are as follows,

- 2 gasoline pumps, $270.00
- 1 handcar, 500.00
- 3 handcars, 225.00
- 1 steam pump, 95.00
- 1 gas engine, 250.00
- 1 steam saw, 75.00

These, with some smaller appliances, such as grind stones, saw sets, and files, total up to about $1,500.00.

The commissary in connection with the kitchen receives fresh and canned goods daily by way of the logging train. Fresh vegetables and meats are mostly used, the canned goods being mostly fruits. About the following amount of stores are kept in reserve.

- 6 doz. 7 gal. cans apricots
- 4 doz. 7 gal. cans plums
- 8 doz. 7 gal. cans tomatoes
- 12 bu. potatoes
- 1 sack onions
- 1 sack beans
- 1 bbl. coffee
- 1 chest tea
- 24 doz. cans milk
- 7 gal. baking powder
- 3 doz. 7 gal. pumpkins
- 2 doz. sides bacon
1 doz. hams
½ sack raisins
1 side beef
30 sacks flour
1 bbl. vinegar
4 cases eggs
40 lbs. butter
2 bbls. sugar
1 sack dried apples
1 sack prunes
50 lbs. rice
2 boxes soap
condiments

The men are charged $5.00 per week for board, the actual cost of feeding them per capita being about $15.00 per month. This makes the cost of feeding the crew of eighty-five men $1,300.00 approximately, per month.

At present, the crew in this camp is composed of 105 men, eighty-five of which stay at the camp. Ten Japanese are employed on section work, who live apart from the main camp. They feed themselves, but are given buildings to live in, by the company. The other ten men live at home, in a near by village, or in small cabins in the woods. The composition of the crew, and wages for each position, is as follows,

Superintendent $1800.00 yearly
Foreman 1500.00 "
Head bucketer 3.25 daily
4 head fallers, at, $3.50
4 second fallers, 3.00
8 buckers 3.00
6 donkey engineers 3.00
6 " firemen 2.50
5 " wood bucks 2.50
3 head rigging men 3.00
3 hook tenders 4.00
3 second rigging men 2.75
3 snipers 2.75
6 chasers 2.75
1 hooker on 2.75
3 rollway men 3.00
3 whistle boys 1.10 and board
8 wood cutters 3.00
1 blacksmith 3.00
3 assistant blacksmiths 2.50
1 saw filer 3.50
3 locomotive engineers 4.25
3 " firemen 3.50
3 brakemen 3.50
7 swampers on new road 3.00
1 cook 3.00 and board
1 flunkey 1.00 " "
1 flunkey 1.35 " "
1 bull cook 1.10 " "
1 raftsman 3.25
1 " 3.00
10 Japanese section men 1.90
The first thing to be done in the actual operations of logging, is the falling of the trees. This is done by the fallers, working in sets of two. The equipment for each set of fallers comprises two 3 foot Simonds falling saws, costing $6.00 each. These are used alternately, each being filed about every one and one half days. Each set has also two 4½ pound falling axes made by the American Axe Co., costing $1.25 each, one 10 pound sledge costing $1.80, two wedges and several wedge plates. The last two mentioned articles are made in the camp shop, the wedges from bar steel, and the plates from broken saws. Wedges are worth about $.75 each. Each set has also two spring boards, and one or more oil bottles.

There are four sets, each having its head faller, who assumes all the responsibility in falling the trees so that they will not be broken, and the second faller who assists in the sawing, and carries the tools.

The first thing in falling is to determine where the tree should lie. They are usually fallen away from the donkey, or away from the first main block, if the haul is not direct. The head faller determines the exact place to fall it by sighting in with his axe handle, and is governed by the lean of the tree, fallen logs, wind and position of other trees. The bottom of the undercut is made with the saw, and then a chip taken out with axes. The depth of the cut is determined by the lean, wind, species and other more or less important factors. The cut is then
made so as to meet the bottom of the undercut, and the tree wedged if necessary. The average day's work for each set of fallers is 30 M feet.

When the trees are fallen, the head bucker marks them into lengths, being guided usually by orders for certain sizes sent from the mill. After they are marked, the buckers which are eight in number, or two to each falling set, saw them into logs. The average day's work for each bucker is from 12 M to 15 M feet. The tools used by each are one 8 foot Simonds bucking saw, costing $7.00, one Hurd swamping axe costing $1.25, one ten pound sledge, $1.80, and two wedges. The value of all the tools used by the buckers and fallers is $125.00. The cost of felling and bucking is about $.50 per M.

The work of getting the logs from where they lie in the woods, to the loading decks is accomplished entirely by the use of donkey engines and cable.

In this camp there are three distinct skidding units, or lines as they are called in the woods, each consisting of a spur of the railroad, a loading deck, and the necessary donkeys and crew. The loading deck or rollway, is an inclined bed of logs sloping down even with the tops of the flat cars which are run in at the lower end. A large roading donkey sets back of the deck, and carries the line out into the woods which brings in the logs. A roading donkey has 1,500 feet of main line, which is drawn out into the woods by a trip line, of which each roader has 5,000 feet.

The logs are first limbed and sniped by the sniper
who trims off the limbs and knots, and rounds the corners of the forward end of the log. They are then hooked onto the main line by the rigging men, with short lengths of chain and line, called chokers. The log, or logs, as sometimes three or four smaller ones are hauled at once, are followed by a chaser, who frees the line from the large blocks used in making turns. A whistle cord along the main line is used for giving signals to the donkey engineer, and is operated by a whistle boy.

When the logs are drawn in to the upper end of the deck, they are unhooked, and rolled down and blocked on the landing till they are loaded. On one of the lines, a yarding donkey out in the woods is used to haul the logs the logs in to the main line. This is because the haul is too long and difficult to be made with one donkey. Here the logs are unhooked, and then attached to the main line by the hooker-on.

The logs are skidded onto flat cars by means of tackle suspended from several upright poles, and with power furnished by a loading donkey. At one of the decks, a small engine attached to the front of one of the locomotives, is used for this purpose. Many devices and methods of working rigging are employed by the men, to accomplish the desired end in both skidding and loading.

The donkey engines have upright, internally fired boilers, and two cable drums connected to the fly wheel by gearing. There are six large ones in the entire camp, ranging from 30 to 45 HP, and three small loading donkeys, of about 20 HP.
The cost of these averages $2,500 each, making the outlay for donkeys $22,500. The main line on the large donkeys is composed of 1,500 feet of one and one eighth inch cable, costing $375.00. The trip line is 5,000 feet of five eighths inch cable, costing $750.00. This makes the entire cost of line for the three large roaders, $3,375.00. The other six carry lesser amounts of line, that carried by them being worth about $3,000.00. This makes the entire cost of line over $6,000, which with the cost of blocks, tools, peavys and other equipment, and the cost of the donkeys, makes a total for the skidding outfit of about $29,500.

The cost of skidding ranges from $1.00 to $1.25 per M. ×

Some of the common terms used in skidding and loading are the following,

Choker a log in loading--to lift by the middle.
Power buckle--is to roll on the car by a loop of line.
Tommy Moore--is a large main line block.
Gin poles--large upright poles from which the loading tackle hangs.
Swamp hook--large hook used in pulling or turning logs.
Monkey block--blocks logs on rollway.
Head block--end block through trip line runs.
Gypsy line--for rolling logs onto rollway.
Snubbing line--to move cars on the siding.
Bunkers--sills on the cars under logs.
Train blocks--on end of bunkers to prevent logs rolling.
Decking irons--for skidding logs onto cars.
Loading line—line used in loading logs.
To siwash a line—to yard by taking a turn around a stump or block.
Rollers—to take the place of a Tommy Moore, in making turns.
Side blocks—carrying trip lines.
Butt chains—to hook onto chokers.

The logs are hauled from the woods to the main line on flat cars over four miles of road. At the end of the woods road the cars are switched onto the main line which is six miles long, and hauled to the river.

The cost of construction per mile of the road is about $800.00, including and laying the track. The rails used are 56 and 60 pound, costing $3,500 per mile. Ties are brought from the company's mill, and cost $500 per mile. The entire cost of the road per mile is $5,000.

The maximum grade possible is 15%, the average being about 7%. The ties in many cases are laid on timbers, which does away with much expensive grading and filling. The road follows the sides of the draws, avoiding making turns by means of switch backs. All trestles are built of logs laid directly on the ground, and built up crib fashion. The switches which are about twenty in number, are of the ordinary throw pattern.

Construction work is done by part of the camp crew, and all section work is done by ten Japanese.

Three locomotives are used, all of which are standard gauge. The two used on the woods line are geared Shay engines, burning wood, and costing $7,000 each. Their capacity is hauling five empty flat cars up a 7% grade, or haul-
ing twelve loaded cars down the same grade.

The engine on the main line is a Baldwin oil burner, costing $10,000. The crew of each locomotive consists of an engineer, fireman, and brakeman. The cost of hauling the logs from the woods to the river is about $.50 per M.

At the river, the main line runs out over deep water on trestle work, and the logs are dumped into the river. Here they float down several hundred feet, where they are caught and made into rafts by two raftsmen.

The rafts are 50 feet wide and 756 feet long, and are formed by chaining logs 63 feet long, called boomsticks together at the ends. Every 60 feet, a cable called a swifter is placed across the raft, the ends being made fast to swifter rings, which are rings fastened to the ends of the boom chains. It requires 11 swifters for every raft. The company has 26 sets of boomsticks.

When the raft is completely made up, it is scaled. The equipment of the scaler is a scale stick, ten foot pole, and tally book. The scaling begins at the lower end of the raft, and is continued forward, going from side to side first taking those logs under swifters, and then those which are not under swifters. The measurements taken are the length and the diameter at the small end. These are noted in the tally book, and the contents afterwards computed from a scale book. Scribner's scale is used. Dimensions are decreased in accordance with the seriousness of defects if such occur.

After scaling, the rafts are towed up to the mill by steamer, the cost of rafting, scaling, and towing being
about $.50 per M. Here they are scaled again when they are taken out of the water, thus checking up the first scaling. The output of this camp averages 125 M feet daily.

A detailed cost of the entire working equipment of this camp is as follows, the figures of course, being approximations.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railroad track</td>
<td>$50,000</td>
</tr>
<tr>
<td>&quot; engines</td>
<td>24,000</td>
</tr>
<tr>
<td>&quot; cars</td>
<td>21,000</td>
</tr>
<tr>
<td>Skidding equipment</td>
<td>29,500</td>
</tr>
<tr>
<td>Camp buildings</td>
<td>400</td>
</tr>
<tr>
<td>&quot; furniture</td>
<td>250</td>
</tr>
<tr>
<td>Shops, tools, etc.</td>
<td>1,500</td>
</tr>
<tr>
<td>Store</td>
<td>600</td>
</tr>
<tr>
<td>Cooking outfit</td>
<td>550</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$127,800</strong></td>
</tr>
</tbody>
</table>

The cost per M for all of the operations of logging from the woods to the mill is as follows,

<table>
<thead>
<tr>
<th>Operation</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felling and bucking</td>
<td>$.50</td>
</tr>
<tr>
<td>Skidding</td>
<td>1.25</td>
</tr>
<tr>
<td>Hauling</td>
<td>.50</td>
</tr>
<tr>
<td>Rafting and towing</td>
<td>.50</td>
</tr>
<tr>
<td>Depreciation of equipment</td>
<td>.50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$3.25</strong></td>
</tr>
</tbody>
</table>