COST AND METHODS OF CONSTRUCTION OF TRUCK LOGGING ROADS

BY

MORRIS BARNETT

A THESIS

PRESENTED TO THE FACULTY

OF THE

SCHOOL OF FORESTRY

OREGON STATE COLLEGE

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

June 1940

Approved:

[redacted]

Professor of Forestry

COMPARATIVE TRUCK COSTS IN THE DOUGLAS FIR REGION

Owner	Driver /M	Tires /M	Gas & Oil /M	Repair Parts /M	Insurance /M	Depreciation/M	Other Items/M	Length of Haul	Total Cost /M	Remarks
1	-	-	-	-	-	-	-	7½	1.75	Contract Operation
2	-	-	-	-	-	-	-	32	3.71	Contract Operation
3.	.69	.25	.48	.10	.28	.40	-	18	2.21	Private dirt roads. Some 15% adverse against empties. No mt'n. Insurance etc included
4	.15	-	-	-	-	-	-	18	2.25	Contract Operation
5	.15	.07	-	-	.07	.20	-	½-1	1.53	New operation, no tire expense, depreciation, or mt'n. Insurance included. Heavy trucks, big loads. Expects much higher costs.
6	.58	.58	.45	-	.58	.83	-	52	3.20	Includes tire repair parts and labor, Costs/mile were: fuel .0406, payroll .0528, taxes, including licenses, and interest .0443, depreciation .0754, all others .0466, Total .29
7	.30	.25	.09	-	.07	.60	-	14	1.31	Heavy trucks, some deisels. Big loads. Good private roads Road & mt'n costs .70/M.
8	-	-	-	-	-	-	-	20	2.25	Contract Operation
9	.13	.06	.07	-	.06	.10	.14	2-3	0.51	Private road, contract operation. Heavy equipment.
10	-	-	-	-	-	-	-	-	3.75	Contract 40-miles
11	-	-	-	-	-	-	-	-	4.00	Contract 37-miles

Timberman -- March 1940
West Coast Lumberman --- April 1940

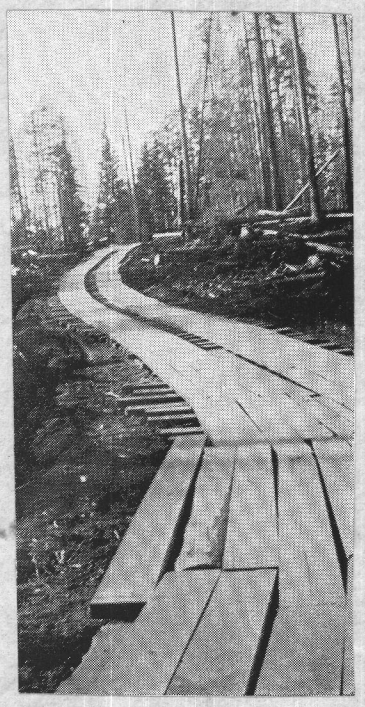
MONTHLY ANALYSIS OF TRUCK OPERATION

	Jan.	Feb.	March	etc.
Fixed Expenses:-				
Depreciation, chassis--less tires				
Depreciation, body				
Interest on total investment				
Insurance				
License				
Taxes				
Storage				
Administrative overhead				
Total Fixed Expenses				
Variable Expenses:-				
Total gasoline cost				
Total oil and grease cost				
Tires--depreciation				
Repairs--chassis, parts				
Repairs--body, parts				
Repairs--body, labor				
Repairs--accident, parts				
Repairs--accident, labor				
Painting				
Washing and greasing, labor				
Truck rental				
Miscellaneous expense				
Total Variable Expense				
Statistical Data:-				
Number days operated				
Number hours in shop				
Average miles/gal. gasoline				
Average total cost/day				
Average total cost/mile				
Average total cost/trip				
Average total cost/stop				
Average total cost/unit				

Timberman -- March 1940

Typical example of a bulldozer at work building truck roads.

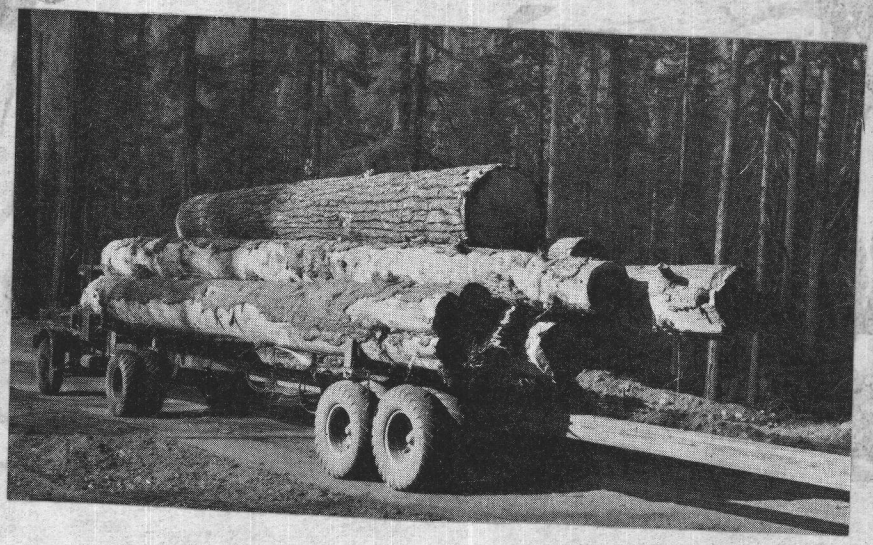
Plank road of Kline Logging Company, Coquille, Oregon, showing truck on the way to railroad. On this section the plank is six inches thick. Lengths from 48 to 56 feet.



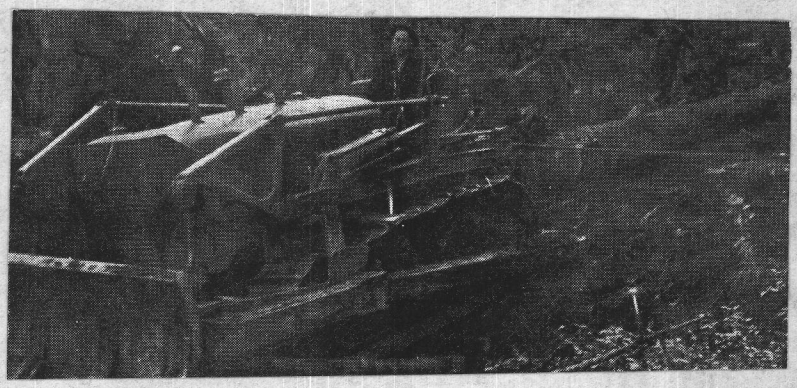
Motor truck road on operations of Consolidated Timber Company. This road is twenty-two feet wide and has twelve inches of crushed rock top dressing. This road cost $10,000 per mile, but the expense was justified. Railroad logging would have been much more expensive in this case.

Planked road of Kline Logging Company, Coquille, Oregon.

Four-inch plank on 12 per cent grade. This must be well sanded. Tangents are three planks wide.



Scenes showing the large loads of logs which may be hauled over graveled truck roads in the Douglas Fir region.



New method of loading trucks with dirt.

Above: Bulldozer chunking out roads.

Below: Bulldozer blade with teeth for getting under roots and rocks so they will come out easier.

Introduction:

Logging engineering as a profession has been encouraged for some years, but during the depression this non-productive activity was cut to a minimum. Engineering activity has expanded rapidly, and the phase, where a line for a hauling route, blazed by the bull-of-the-woods from landing to landing, more or less at random through the brush, has given way to the preparation of intensive logging and transportation plans for extensive areas by trained engineers.

Motor truck logging has created new problems for engineers to cope with. These have called for new engineering techniques and many revisions of the old ones. The demand for economical road construction, and the fact that log trucks can be driven around curves having a radii of only thirty-five feet, have resulted in surveys in which the alignment is fitted more closely to the contour of the ground than is possible on a rail operation. Bridges of the conventional pile and framed bent types have been eliminated almost entirely. This requires the use of many sharp curves. A check of the notes covering approximately eight miles of truck roads recently laid out shows an average of thirty-six curves to the mile with the prevalence of curves having a short radius.

The laying out of truck roads has much more flexibility as to limits in grade and curvature than railroads as trucks are very adaptable.

The purpose of this report is to show comparative costs of Logging truck roads on various shows in the Douglas Fir area of the Pacific Northwest. It is not expected that any definite conclusions can be drawn due to the fact that each show offers different problems to be met, in fact locations may vary almost one-hundred per cent between two shows located in the same region. This report is merely to show the various methods used on a particular show so that anyone who wishes to consult it may use the method which seems the best to him.

The most pronounced trend in logging methods today is toward more extensive use of motor trucks in log transportation. In every region of the West trucks are becoming an increasingly important factor in opening up new tracts of timber. In the past decade thousands of miles of truck roads have been constructed over which approximately ten thousand motor truck units are putting in several billion feet of logs annually.

The use of trucks in other regions in the United States including the South is in fact probably as popular as on the West Coast.

Railroad logging involves a much heavier capital investment than truck logging, and hence is adapted to the operation of large tracts on which a heavy volume of timber can be moved over a given road location. As large concentrated tracts of timber are being cut out, and the industry is gravitating to the operating of

smaller, more isolated tracts, it is obvious that the heavy investment involved in railroad logging creates a great handicap, as on various extensions the volume of timber is not great enough to yield a reasonable depreciation rate on the investment.

Coincidental with the increasing tendency to operate smaller and more isolated tracts of timber, is the fact that these are located on rough ground, over which in many cases it would be practically impossible to operate with railroads. With the advent of the bulldozer and modern dirt moving and road building equipment, there has been a great reduction in the cost of building dirt roads.

I. Variable Factors:

Improvement in tire mileage, trucks, motors, and loading equipment as pertaining to truck logging, have made great strides in the last decade as compared to only a moderate improvement in the technique of railroad logging. Thus in considering the opening up and operation of a tract of timber these two systems of logging, namely by railroad or truck, deserve the most careful scrutiny, and in the borderline cases it is highly advisable to very carefully estimate the cost of both types before arriving at a final decision.

Since railroads have many advantages where large volume can be hauled over great distances, a trend is developing where trucks are used to supplement the railroads, leaving the long, heavy volume haul to the latter.

There are many variable factors concerned with the cost and methods of construction of logging truck roads. The kind and size of the trucks used for log hauling purposes varies from the smallest to the largest trucks on the market, hauling loads which vary accordingly. This has an important bearing on how the roads must be constructed. The bigger the load the better the road must be constructed in order to hold up and not be too hard on the trucks and trucks. The life of the tires depends to a large extent upon the condition of the road even more so than upon the size of the load hauled. The time taken per trip is also a governing factor as to how well the road should be made. Naturally the better the road the less time will need to be taken per trip, and consequently fewer trucks and men will be needed for the transportation of the logs. Most operators construct better roads for large trucks due to the fact that they will haul larger loads. When roads are well constructed there will be a smoother surface, causing less vibration and therefore less breakage of truck frames as well as cheaper operating costs due to being able to maintain higher speeds and thus taking less time per trip. Considering this angle of the question roads should be built as good as is economically possible for small trucks as well as large.

In surveying for the roads some operators use an abney, chain, and box compass, some use hand levels and some go through the same procedure that is used for railroads. Due to the varying degree of accuracy obtained

in surveying by these highly diversified methods the cost will vary from three dollars per mile to as high as four hundred dollars per mile. In most cases reported the cost of surveying will vary according to the use of the road. On spurs the cost is exceedingly low and on mainlines it will be considerably higher.

II. Kinds of Roads:

In the Douglas Fir region the weather in the winter months forces some kind of surfacing on the truck roads. Some outfits use dirt roads during the summer months where the weather will permit while others use plank or gravel roads the year round. The tendency at the present time seems to be towards gravel surfacing of roads. The amount of gravel necessary on a road will vary according to the type of soil, the grade of the road, size of the loads hauled, and whether or not it is used during the whole winter or just at the beginning and end of the rainy season. Roads varying from twenty to forty feet in width are in use as two-way roads, the variance due mainly to the size of the trucks and the maximum degree of curvature used. The fact that too little surfacing is the tendency cannot be stressed too much. A road is no better than its surface. It is a good sound economic policy to apply ample surfacing to any road before heavy duty hauling is attempted. The saving of time, trucks, and cost of maintainance will in most cases more than pay for the cost of building a good road.

Gravel is spread on the roads from sixteen to eighteen inches thick. This is pit run gravel and probably not of the best quality according to standards set by the state highway department. When gravel is spread on this thick it is possible to use the road the year around and haul heavy loads.

The super elevation on curves of logging roads is just opposite that on highways so that the trailer will be sure to swing out wide enough so it will not run off the road on the inside of the curve. Most operators use twelve or fourteen foot one way roads with turnouts every five-hundred feet or oftener depending upon the visibility due to topography or curves. This type of road does not take so much outlay as a two way road, but it does take much deeper gravel and more expense for maintainance. With careful planning good time may be made on this type of road.

On the other hand a wide gravel road does not require such deep gravel, but it must be spread out over more space. Over this type of road the trucks may run faster and travel in different parts of the road instead of using the same tracks all the time thereby requiring less maintainance and providing smoother roads, nor is any time lost waiting on turnouts for another truck to pass.

Plank roads are quite often used for winter logging. They are always one way only, and require frequent turnouts. Turnouts on any type of one way road should not be very much in excess of five hundred feet in order to

prevent tying up the trucks. This type of road does not as a rule require any great amount of maintainance although it will creep some on steep grades. It also has the advantage of being salvaged and used again.

The method of road construction at the present time is simple compared to what it once was. A bulldozer may be used for most any kind of road construction and very economically. In wet weather or in exceedingly deep cuts or fills a shovel is used, but this method is slower and more costly. Gravel is usually spread by the bulldozer except where some kind of a maintainer is available. The maintainer is best suited to this type of work.

When plank roads are constructed the grade is built up in the same way as for a gravel road. Mud plank running lengthwise on the grade are used for a foundation, then cross-plank are put on, and then running plank on top for the truck wheels to run on. A little cheaper type of plank road is to use railroad ties for cross ties and lay the running plank on top of them. This requires considerably less plank and labor. (There are many more types of plank roads too numerous too mention).

III. Grade and Curvature:

The maximum grade allowable on truck roads will vary depending upon the type of road it is, weather, kind and size of trucks, and whether or not the trailer may be loaded. It is possible for trucks to go up a twenty-five per cent grade with the trailer loaded. In the reports received from several companies the average favorable grade varies from eight per cent to fifteen per cent and

the maximum goes as high as twenty-five per cent. The percentage of grade which is best to use is dependent on the surrounding country as well as what the trucks will go up empty. If a steep grade is the only way by which a certain area may be logged it will no doubt be the best way. Due to the fact that maintainance costs, operation costs, and the time required per trip raise accordingly it is always best to keep the lowest possible grade without building an excessive amount of road to make this possible. The degree of curvature on truck roads is not limited very closely. About the only limiting factor is the length of the logs hauled combined with the kind and size of the truck used. The sharpness of curves has a direct influence upon the speed which may be travelled so for economy's sake it is usually a good rule to keep the curves as easy as possible.

The length of the logs to be taken out over the road combined with the kind of truck should determine how sharp a curve should be allowable, how much super elevation should be put on the curves, how wide the road should be on the curves, and it should enter into the type of truck to purchase--number of wheels it might have and the length of the trailer tongue etc.

IV. Costs:

The cost of building logging truck roads in the Douglas Fir region is exceedingly variable. This is dependent upon many factors including variation in the type

of material to be excavated, roughness and steepness of topography, number, size, and kind of stumps to be shot, season of the year in which the work is to be done, the distance the surfacing must be hauled and the kind of surfacing. Around Coos Bay plank roads are almost mandatory due to the scarcity of gravel. Quite often the excessive cost of any one of these items governs profit or loss on truck logging jobs.

It is very seldom that it will pay to build a road costing very much over five thousand dollars per mile although the Consolidated Timber Company built a road costing ten thousand dollars per mile and claims that the cost was justified. However, this must be an extreme case. Most truck loggers will agree on the fact that the cost of the truck roads may make or break an outfit.

Sample of costs per one-hundred foot station:

Felling and Bucking	$2.00---8.00
Shooting Stumps	5.00--12.00
Grading	10.00--50.00
Total	17.00--70.00

Gravel costs vary from fifty cents to one dollar per cubic yard depending upon the availability and distance which it must be hauled. The cost of plank for plank roads is usually dependent upon local conditions, but thirty-five hundred dollars per mile is about an average figure.

V. Maintainance:

The methods of maintainance of logging truck roads

are somewhat variable. Plank roads are all maintained by hand. The big part of keeping plank roads up is merely to keep the broken planks replaced and to keep the spikes driven down. During the winter months plank roads must be sanded on frosty mornings as the planks become very slick making it impossible to go upgrade. Several methods besides sanding have been used to gain traction over plank roads on frosty mornings. Tar has been mixed with sand for this purpose but has proven unsatisfactory as the tar will crack off. Strands of worn out cable nailed crossways to the planks have proven fairly satisfactory. Trucks may go up a fifteen per cent grade pulling a trailer with the help of these strands. Worn out cable strands and sand are the only ones that have proven satisfactory for frost as well as mud getting on the planks. Salt has been used to get rid of the frost and it will do a very satisfactory job of it, but the cost factor enters in decidedly against it and it is of no help in case of mud anyway.

Gravel roads must be dragged by one way or another every day and should be watered when used in the summer months. Some operators still use the old fashioned drag to smooth the roads down and have men with shovels fill in the chuck holes. This system, however, is getting rather outdated due to the low cost of some kinds of maintainers which can do a better, more efficient job in less time and with fewer men. When dirt roads are in use they must

be watered and graded almost continuously in order to keep them in good condition.

The cost of maintainance of a road depends somewhat upon the effectiveness of the drainage system provided and upon the surface originally put on the road. The weight of the load as compared with the size of the tires and whether it is a one way or a two way road, and how much use the road is given along with the grade also figure strongly here. If the mud breaks through at a number of points, all surfacing below the mud line is wasted, and the weak spots must be stabilized. Maintainance costs will vary from ten cents to fifty cents per thousand depending entirely on the above mentioned factors.

The cost per thousand of the roads depends on the stand per acre, and the volume in the average tree as well as difficulties in physical construction. How much money should be spent for a road is dependent to a certain degree upon how many thousand feet of timber are to be taken out over that road as this factor determines cost per thousand. The significance of the cost per thousand varies with the selling price of logs. Low cost is mandatory in poor timber while a much higher cost is justified in good timber.

When a tract of timber is being opened and it has been determined that it shall be operated primarily by trucks the question arises as to what kind of trucks and the type of roads to be used and the general layout of the

road network. Following is a rule of thumb for calculating hauling cost with gasoline equipment. This should help the engineer to determine what type of road he should build.

Basic standby charge	$1.00[1]
Add per thousand per mile:	
Company road unimproved	0.17
Company road improved	0.12
Public road improved	0.10
Public road paved	0.07
For each 1% per mile adverse grade up to 3% inclusive	0.01
For each 1% per mile adverse grade up to 4% to 7% inclusive	0.03

This rule of thumb shows that it is cheaper to haul over improved company roads in most cases. It also shows that adverse grades will run hauling into big figures. Five per cent adverse grade is the steepest recommended, although trucks may go up steeper grades than this when loaded if it is necessary. Steeper adverse grades cut the loads down considerably, and make the time taken for a trip considerably longer. Adverse grades should be avoided entirely whenever possible.

VI. Conclusion:

Road building is an important part of motor truck logging, not only as an item of expense, but because the care and skill used in location and construction control

1. From Cost Sheet obtained from Professor Patterson

the profitableness of the entire operation. In general the better the road the lower the cost of truck operation. At the same time it is not profitable to build a better road than needed as the economies effected in operation may not offset the increased road cost. Actually the true cost of hauling is a combination of roadway and vehicle costs.

Road location in the woods calls for no high degree of engineering skill. The locator has a wider leeway in choosing grades and alignments than in highway or railroad location, and the simpler engineering instruments are suited to his purpose. In the preliminary location, the road must pass by the various landings, avoid heavy construction, and tentatively present a route upon which it is safe to travel. Economy determines the details of the final location.

Bridges can be avoided more easily on truck roads than on railroads due to the fact that trucks can go up or down steeper grades. Wherever possible fills are preferable to bridges anyway as they will last much longer, and not have the fire hazard that bridges have. The biggest danger of fills is that they may wash out, but this is not apt to happen if adequate culverts are provided. There is no comparison between the cost of an adequate culvert and the cost of rebuilding a fill which has washed out.

Tires for trucks have been improved somewhat during the last few years. Front tires never have been much worry due to the fact that they have only a small part of the weight placed upon them. Tires on drive wheels a few years ago would give only about eleven thousand miles of service where they now give an average of about twenty-five thousand miles. This is possibly due to some extent to the improvement in truck roads. Many operators claim that a plank road is easier on tires than any other type of road. Crushed rock roads cut the tires rather badly. While gravel does not cut the tires as crushed rock will the tires pick up gravel which bruises them especially when they are loaded. Tires with mud-grip tread are best on gravel roads as they do not pick up the rocks.

The road should be well ditched with ditches of ample size to take care of the largest amount of water ever occurring at one time as it is much easier and cheaper to dig ample ditches in the first place than it is to rebuild washed out road.

Under ordinary conditions roads should not cost over one dollar per thousand, and maintainance costs should not be over fifty cents per thousand. There are cases, of course, where a greater expenditure than this would be justified, but this class of timber is rapidly becoming very rare.

No set rules can be followed as to how to lay out or build truck roads, and although costs for various outfits

may be obtained one cannot be assured that the cost items which he has may even begin to compare as truck logging is in an experimental stage. Experience is the only sure way of judging what should be done and even this is not too good. Due to nature everything is different in work of this kind and as yet there has not been enough information on truck logging to make the information reliable. However, evidence does point to the fact that large trucks hauling fairly heavy loads over well constructed roads will cost less per thousand although the initial outlay will be greater.

REFERENCES

The Timberman March 1939
April 1939
September 1939
November 1939
March 1940

West Coast Lumberman August 1939
September 1939
April 1940

Logger's Daily--Pacific Logging Congress--October 11-14, 1939

Motor Truck Log Hauling in Oregon and Washington--
by E. J. Rapraeger

Willamette Valley Lumber Company

O. P. Lewellen

Kline Logging Company

Santiam Logging Company

Holmes Logging Company

C. E. Powell

I also wish to acknowledge those companies who contributed information for this thesis, but who did not wish to have their names published.