OCTOBER 1976 EQUIPMENT DEVELOPMENT AND TEST REPORT 7700-11

CLEARING, GRUBBING, AND DISPOSING OF ROAD CONSTRUCTION SLASH

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by

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ABSTRACT

A review of Forest Service road construction contracts reveals that, over the past few years, road construction costs have rapidly increased. Part of this increase in costs involve the tasks of clearing, grubbing, and disposing of slash from within the construction limits. Clearing and grubbing costs vary greatly depending on the type and amount of vegetation, climate, slopes, type of road, methods required, and other miscellaneous costs contractors inject into their bids (e.g., move-in and move-out). This report concludes that fire prevention and air pollution abatement controls have been a direct cause of the rising costs of clearing, grubbing, and disposing activities. Air curtain burning and chipping are presented as possible methods to reverse this rising trend in slash disposal costs.

KEY WORDS: Clearing, grubbing, disposing, road construction, air pollution abatement, air curtain burning, chipping, steep slope road construction.

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A report on ED&T Project No. 2157—Clearing and Grubbing Methods for Road Construction—sponsored by Engineering, Forest Roads and Trails

INTRODUCTION

Over the past 20 years the rise in road construction costs has been astronomical. One major contributor to this has been the cost of clearing, grubbing, and disposing of slash from within the road construction limits. This rise in clearing, grubbing, and disposing costs is borne out by a review of contract bid tabulations.

One Forest Service region reported that, in 1956, clearing and grubbing costs were approximately 10 percent of the total construction costs. In 1974, these costs had risen to approximately 26 percent of total costs. What caused this cost increase? Was it caused by lack of improvement in equipment (i.e., no increase in efficiency), or because of environmental impacts and safety restrictions? The simple sketch in figure 1 poses these questions.

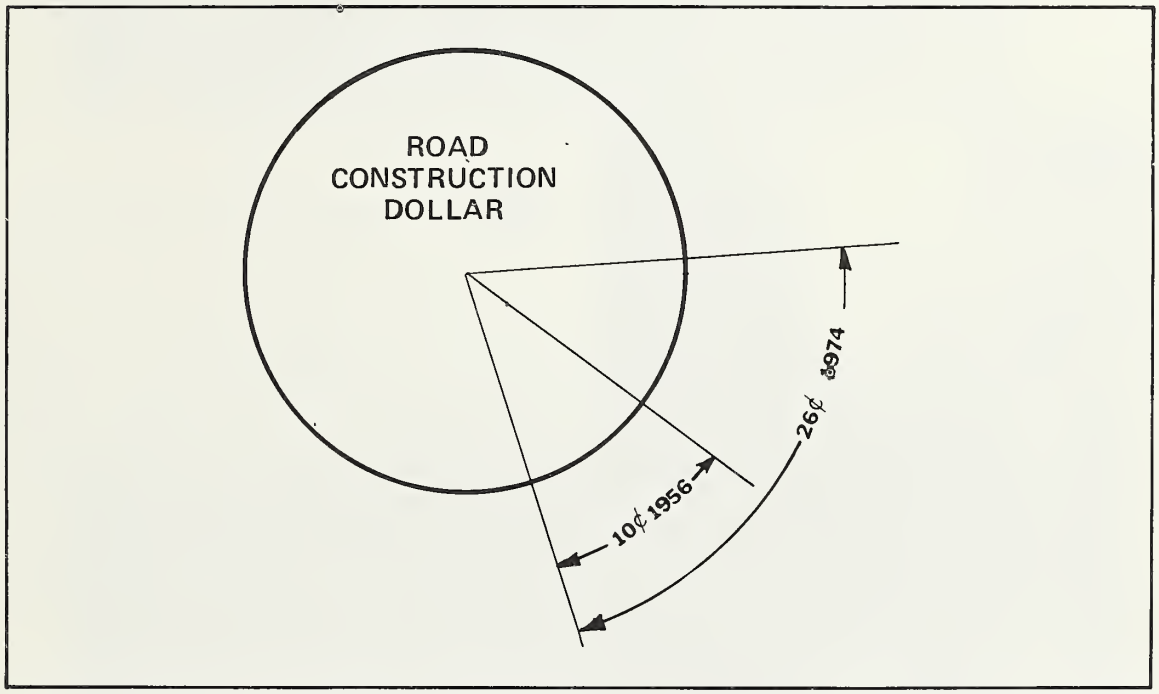

Figure 1. Bite of clearing, grubbing, and disposing out of road construction dollar, 1956-1974.

These rising costs indicate an urgent need for a more practical and economical method to clear, grub, and dispose of slash resulting from road construction. In slash disposal, a relatively new, significant consideration is air pollution abatement requirements imposed by governing bodies (city, county, State, and Federal) and the impact they have on road construction.

This project was a study of current practices and methods being used to accomplish clearing, grubbing, and disposal of road construction slash. Part of the study was defining the problems in these activities: (1) to determine equipment needs which would reduce construction costs, and (2) to find methods of disposing slash which would eliminate problems in air pollution from the burning of slash.

PRACTICES AND METHODS

Nine Regional Offices and 30 Forests were visited to determine their current practices and methods for clearing, grubbing, and disposing of slash from within road construction limits, and also to obtain data for future improvement. These practices and methods are outlined in the following paragraphs.

Clearing

Clearing is the removal of all trees, snags, down timber, brush, and other vegetative debris from within the construction limits. Clearing activity, for the most part, consists of cutting trees with chain saws. Brush is often removed with the topsoil using dozer blades. Trees are cut and limbs are removed. Then the trees are bucked into logs. Merchantable logs are skidded to log decks for storage until the road is completed enough for truck transport (fig. 2).

Figure 2. Loading logs from a log deck.

Grubbing

Grubbing is the removal of stumps and roots from the ground within the roadway. Stumps within embankment areas are left in place if they do not interfere with placement or compaction of the embankment. Stumps outside of the roadway that would interfere with road maintenance are removed. Three general grubbing methods are:

1. Loosening stumps with explosives and then working the stumps out of the ground and removing them with a dozer blade.

2. Removing stumps with a dozer equipped with a stinger on the rear (fig. 3). The stumps are split into several pieces by the stinger and then pushed out by the dozer blade. This has to be a situation where there are many large stumps and fairly level terrain. Otherwise, the unit and operational costs would not justify this method.

3. Using a 1½-yd shovel for the total clearing and grubbing job, a procedure used in the muskegs of Alaska. Supported on timber mats, the shovel walks its way along, pulling stumps, decking logs, and—on hillsides—excavating for the roadway.

Figure 3. D9G with a stinger mounted on the rear.

Disposing

Burning

Burning is currently the most common method for slash disposal. Burning is often so incomplete that large quantities of residual slash are subsequently buried (fig. 4). Fire prevention and air pollution control requirements result in incomplete burning because burning can only be done when atmospheric conditions permit. Some air pollution controls

Figure 4. Slash to be burned and buried.

Figure 5. Burning road slash.

require slash to be air-dried for 60 days. The residues of clearing and grubbing in the spring cannot be burned until the summer, which is usually the period of high fire danger. Burning (fig. 5) must then be delayed until conditions permit, or the slash must be disposed of by burying.

Burying

Burying is currently the second most common method of disposal. Depending upon the disposal site, whether it be away from the road, or a trench extending from the clearing

Figure 6. D6C with brush blade.

limits, the site must sometimes be cleared and grubbed. In heavy timbered areas, the site itself creates more slash to be disposed of.

One unusual, but efficient, operation was observed, consisting of a D6C with brush blade (fig. 6), a 977H track loader with a log stacking attachment (fig. 7), and a D9G dozer with stinger (fig. 8). Most road builders do not have this much equipment. The D6C piled slash within the roadway. The D9G excavated trenches for the slash. The 977H stacked the slash

Figure 7. 977H track loader with log stacking attachment.

Figure 8. D9G dozer with stinger.

in the trenches and decked merchantable logs. The D9G split and removed the stumps which the D6C pushed into the slash piles. The D9G compacted the slash in the trenches and covered them with soil. Normally, only one piece of equipment such as a D7 (fig. 9) is used for this type of operation.

Figure 9. D7 burying slash.

Figure 10. Scattered slash.

Scattering

Scattering is limited and not being done in most road construction projects. This consists of scattering stumps, brush, limbs, and other slash outside the roadway. This is done in areas where no damage to the stand will occur and positioned so the slash will not roll down slopes. Scattering is mostly done on the older timber sales (fig. 10).

Windrowing and Leaving to Decay

Windrowing consists of placing neat, compacted rows of limbs, brush, stumps, and trees in windrows parallel to and along the toeline of fill slopes, where they are left to decay (fig. 11). Very little windrowing is currently being done. A successful windrowing operation in the Southern Region is construction of brush barriers (fig. 12). These barriers

Figure 11. Windrowed slash.

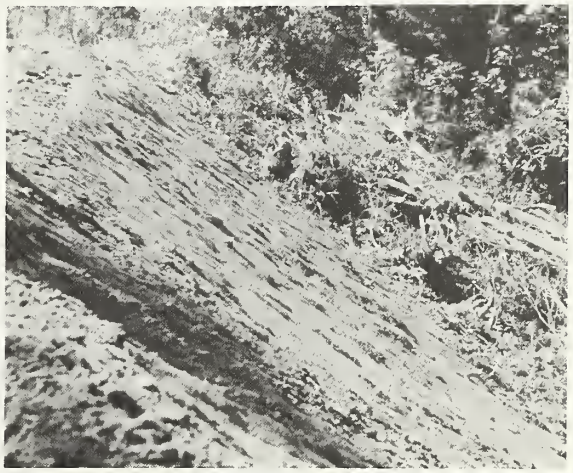

Figure 12. Brush barrier.

are stacked parallel to fill slopes to check erosion and prevent soil from going into rivers and streams. Brush barriers are usually formed with a D6 tractor equipped with a brush blade. Stumps are not put in the barrier but are disposed of away from the road. Brush barriers are not too visible after 2 or 3 years because of vegetation growth on the trapped soil and decomposition of the brush.

Removing

Complete removal of slash is required on many road construction projects because no disposal is permitted on site. Stumps and other slash are loaded into trucks and hauled to a disposal site for burning or burying.

Chipping

Chipping is wood processing by machine methods where slash, generally in log form, is reduced into chips of more or less uniform size. Chips may be deposited on fill slopes or outside of the roadway as long as the uniform depth is not more than 6 inches. Chips may also be permitted within the roadway if they are thoroughly mixed with rock or soil and do not form a layer. Where there is more than a small amount of slash, very little (if any)

chipping is done on road construction. Chipping is more confined to road maintenance brush disposal than to road construction slash disposal.

Steep Slopes

Some of the greatest problems in clearing and grubbing are encountered on steep, heavily wooded, mountainous terrain. If large dozers are used to pioneer single-lane roads, considerable amounts of slash are buried beneath the soil forming the pioneer road. This causes two problems: (1) slash forms a layer between fill material and the ground; and (2) topsoil containing considerable organic matter forms another layer over the slash. When these two layers are between the fill and natural ground, water follows the layers, resulting in a slip plane between the embankment and the ground. Also, good compaction is impossible for the first few feet of fill when it is over a spongy layer. The smaller organic material such as leaves, brush, small branches, and humus may decompose, causing the road fills to slide or settle, with possibility of complete failure.

Much National Forest terrain has slopes ranging from 40 to 75 percent. This precludes the use of conventional equipment in carrying out effective clearing and grubbing activity. Many of the more difficult areas are not fully utilized. Hand labor has been used, but is limited in scope and is expensive.

A feasibility study (5) was made by the San Dimas Equipment Development Center (SDEDC) to determine the possibilities of using a self-contained tethered cable system on slopes of 20 to 75 percent. Although not tried, it was determined analytically that equipment utilizing such a system could possibly operate, with certain limitations, on slopes of 20 to 75 percent.

MECHANICAL EQUIPMENT

Since the inception of equipment development for effective Forest Service treatment and utilization of slash, SDEDC engineers have investigated and evaluated many different pieces of equipment. As stated by Harrison (1), most mechanical equipment was not designed for Forest Service use and, therefore, does not adequately treat slash. Equipment and methods for the treatment and utilization of other slash, such as that created by logging operations and thinning of timber stands, are beyond the scope of this report. The equipment or methods to dispose of road construction slash created by clearing and grubbing activity are discussed in the following paragraphs.

Burning

Slash disposal by burning creates many problems. When slash is dry enough to burn, it is usually in the period of high fire danger. Also, when conditions do permit burning, much unburned slash remains due to incomplete burning. In addition, the air is polluted by smoke; therefore, special equipment must be utilized to attain clean burning. To produce clean (no smoke) burning, a temperature of at least 1,600° F must be reached. This can be accomplished with air curtain burners. This treatment approach consists of dumping unusable slash material either into earth pits or into large fireboxes and using forced air to achieve intense combustion and to drive volatile gases into an air curtain where secondary combustion takes place. This results in a complete, no-smoke burn that also destroys hydrocarbons that escape into the air in broadcast or pile burning (4). Air curtain burning has proven to be one of the most effective methods of treating slash. Total treatment time is short and remaining residual is less compared to other burning techniques.

Air Curtain Destructor (ACD)

The ACD (fig. 13) is manufactured by DriAll, Inc., Attica, Ind. This unit requires a pit of up to 42 ft in length, 8 ft in width, and 15 ft in depth. The pit can best be excavated with a backhoe. The ACD will burn up to 21 tons of slash per hour at an approximate operational cost of $5.70 per ton. This cost is as of May 1972 and includes site preparation and cleanup, ACD amortization, support equipment, and personnel.

Figure 13. Air Curtain Destructor.

Air Curtain Combustion Unit (ACCU)

The ACCU (fig. 14) is manufactured by The Camran Corp., Seattle, Wash. This unit is a mobile burning enclosure. It consists of a trailer-mounted, hopper-shaped combustion unit with 6-in thick precast refractory wall panels. Loading is accomplished with a built-in hydraulic grapple loader. The ACCU will burn from 10 to 15 tons of slash per hour. As of June 1975 the operating cost of the ACCU is $30 per ton on a contract basis.

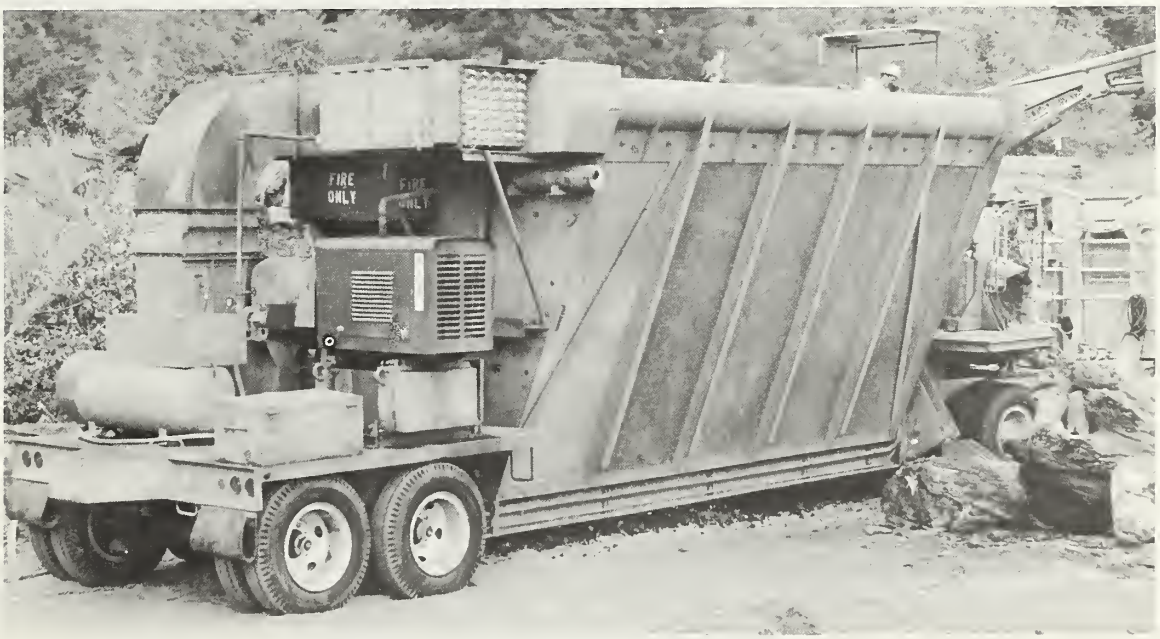

Figure 14. Air Curtain Combustor.

Advantages/Disadvantages of Air Curtain Devices

Air curtain devices offer certain advantages over open burning or normal incineration:

1. Forced air increases the amount of oxygen to the fire for intense combustion, and particles are suspended in the incoming air stream long enough for essentially complete combustion.

2. Nearly all particulate matter and smoke are confined within the pit or enclosure.

3. Only a relatively small land area is affected by heat.

4. Fire hazards are reduced.

5. Negligible residue (less than 1 percent) remains after a burn.

There are certain disadvantages encountered with the ACD and ACCU:

1. The ACD requires a pit in firm and compact soil to maintain satisfactory walls.

2. The ACD requires the slash to be brought to the unit. This requires more handling of slash than the ACCU.

3. The ACD depends upon the pit length for the length of the slash to be burned and the ACCU depends upon its size and boom capacity for the length of slash it will handle.

Chipping

There are many large mobile chippers on the market for harvesting wood chips. These machines are not constructed to handle soil and rocks embedded in or covering stumps, or slash encountered in road clearing and grubbing activity. SDEDC has observed various drum-type chippers, two of which are described in the following paragraphs.

Nicholson Ecolo Chipper

The Ecolo Chipper (fig. 15) is manufactured by the Nicholson Manufacturing Co., Seattle, Wash. The Ecolo Chipper is designed to chip building debris and railroad ties, as well as slash mixed with dirt and rocks. Chipping capabilities of the Ecolo Chippers vary from 40 to 225 tons per hour (1). No operating cost factors were obtained; therefore no cost analysis can be made comparing other methods.

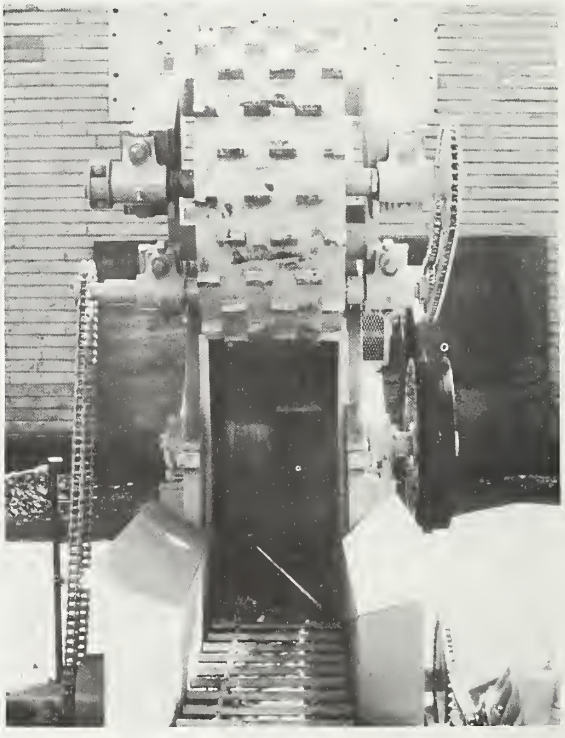

Figure 15. Ecolo Chipper.

Vermeer 671 Log Chipper

The Vermeer 671 Log Chipper (fig. 16) is manufactured by the Vermeer Manufacturing Co., Pella, Iowa. The 671 Log Chipper is a trailer-mounted, cylindrical drum chipper designed to pulverize logs, railroad ties, scrap lumber, and other bulky material. When chipping logging slash, the 671 averaged only about 7 tons per hour (3). Total hourly operation costs were determined to be $71. Using 7 tons per hour as the chipping rate, slash disposal cost was $10 per ton. The 671 Log Chipper is not recommended for general use on heavily wooded forests and roads because it cannot process large amounts of slash quickly.

Figure 16. Vermeer 671 Log Chipper.

Figure 17. Wick-Bartlett Stump Harvester.

Stumps

The Wick-Bartlett Stump Harvester (fig. 17), manufactured by the Wick Industries International, Vancouver, Wash., shows potential in road construction clearing and grubbing operations. This equipment is designed to remove large stumps and also to cut up root wads and cull logs. This readily aids disposal by splitting stumps into flat sections that may be easily buried, burned, or chipped, and by shaking dirt and rocks from stumps, which allows better burning and opens up more possibilities for chipping. The Stump Harvester may also be used for piling slash and logs.

COSTS

From information obtained from the regions and Forests, clearing and grubbing costs vary from $500 to $6,900 per acre, depending on the type and amount of vegetation, climate, slopes, type of road, and methods required.

Clearing and grubbing unit costs vary greatly because of miscellaneous costs the contractor injects into his bid. For example, move-in and move-out costs are sometimes included, and pioneer road construction costs may also be included to make up the difference in unit costs with the regular excavation item.

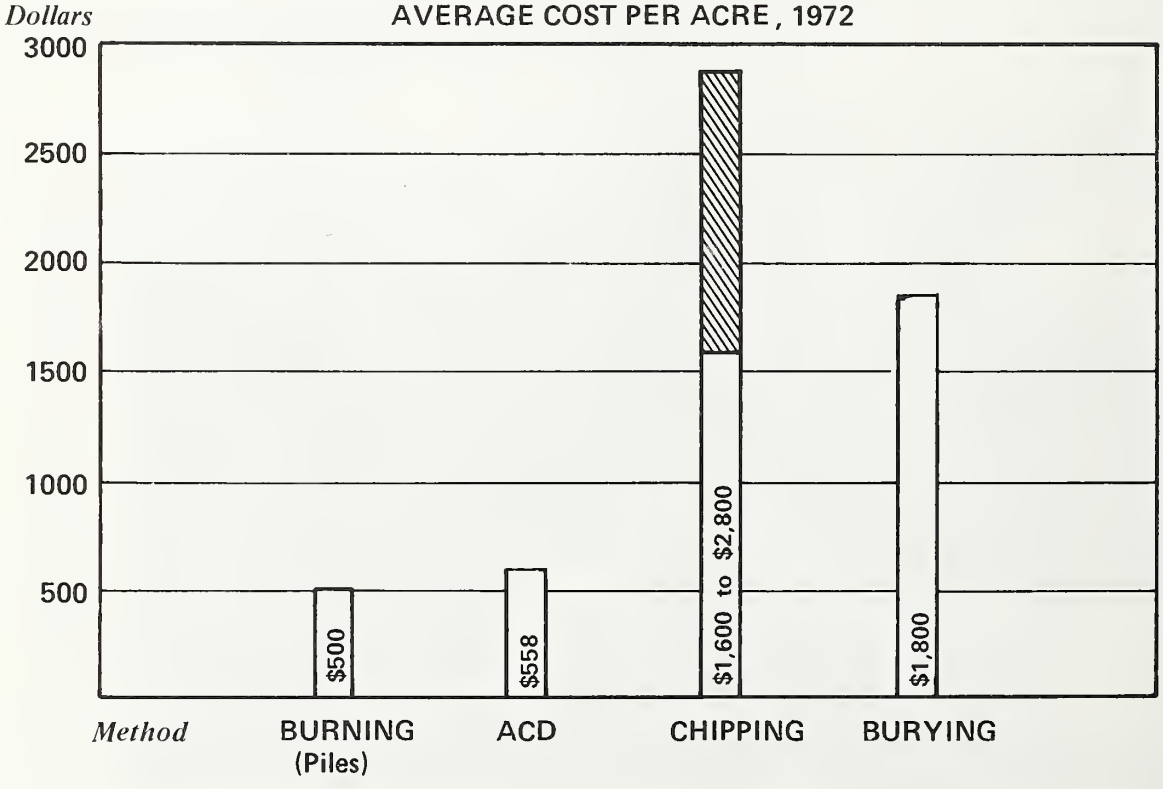

Figure 18. Relative cost (1972) of slash disposal—four methods.

There were 7,237 miles of Forest roads constructed in FY 74 at a cost of $136 million. Using $1,200 per acre—an average unit cost [1/] for clearing, grubbing, and disposal—the estimated expenditure for these incidentals would be $35 million. This is approximately 26 percent of the total road construction cost. Clearing costs appear to be approximately equal to grubbing costs.

The relative cost for slash disposal by four methods is graphically shown in figure 18. These statistics were compiled by Humphres (2) and Lambert (4). These costs do not include felling and bucking of trees, or removing stumps and roots, but do include the cost of slash handling and disposing.

Substitution of air curtain burning would eliminate the burying of slash and result in a $1,300 per acre average savings. [2/]

Chipping is more confined to timber harvesting rather than to road construction, therefore, an accurate comparison cannot be made.

CONCLUSIONS

More stringent requirements in slash disposal by fire prevention and air pollution abatement controls have increased the relative cost of clearing and grubbing as compared to the total construction costs.

Air curtain burning has proven to be an effective method of treating slash and is a means of reducing slash disposal costs. Also, fire hazard and air pollution are reduced because the smoke and ash are held in suspension within the air curtain.

Chipping is a costly method of disposing slash. If methods were developed for the utilization of the total chip, then chipping would probably be less costly than burying. A chipping machine would have to handle, or separate, soil and rock from stumps and root wads that are a part of road construction slash.

The construction of single-lane roads on steep slopes of more than 50 percent is a problem because considerable amounts of slash are buried beneath the soil forming the road. Developing equipment to clear and grub on steep slopes without the need for a pioneer road may provide an alternative solution. The concept of a self-contained tether cable system for operating equipment on slopes of 20 to 75 percent might have merit as an effective tool in road construction on steep slopes. Other alternatives to consider are limiting the size of equipment constructing the pioneer roads or requiring full bench construction of the roads on steep side hills.

[1/] Unit cost, adjusted to 1974 costs, obtained from averaging the summation of cost data from five Regions. Assume there are 4.0 acres of clearing and grubbing per mile.

[2/] The conversion factor of 98.5 tons of slash per acre was determined by actual weight measurement made during the ACD tests.

Clearing and grubbing is done by timber purchasers and contractors using their own equipment. With the exception of air curtain burning equipment, existing mechanical equipment generally does not adequately treat slash. Programs for the development of new or modified equipment specifically oriented towards the treatment of slash in road construction should be continued.

LITERATURE CITED

1. *Harrison, Robin T.*

   1975. Slash . . . Equipment and Methods for treatment and utilization. ED&T Report 7120-7. USDA Forest Serv., Eqpt. Dev. Ctr., San Dimas, Calif.

2. *Humphres, Herbert W.*

   1972. (Speech) Wash. State Dept. of Hwys.(Presented at 57th annual AASHTO meeting, Miami Beach, Fla., 1972)

3. *Lambert, Michael*

   1973. Vermeer 671 log chipper. Project Record ED&T 2158. USDA Forest Serv., Eqpt. Dev. Ctr., San Dimas, Calif.

4. *Lambert, Michael*

   1972. Efficiency and economy of an air curtain destructor used for slash disposal in the Northwest. Pap. No. 72-672. Amer. Soc. of Agric. Engr., St. Joseph, Mich.

5. *McKenzie, Dan W., and Boone Y. Richardson*

   1975. Feasibility study of a self-contained tether cable system for operating equipment on slopes of 20 to 75 percent. (Paper presented at the Intl. Soc. for Terrain Vehicle Systems 5th Intl. Conference, June 2-6, 1975, Detroit, Mich.) USDA Forest Serv., Eqpt. Dev. Ctr., San Dimas, Calif.

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