Unpaved Roads Maintenance Management

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Unpaved Roads Maintenance Management

A Guide for Counties, Cities, and Towns In Indiana

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and

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INTRODUCTION

Unpaved roads are an essential part of highway management in most Indiana counties and in a few cities that have unpaved roads. This guide has been written to increase understanding of the performance, maintenance and management of unpaved roads. Some of the information provided has been based on results of research by the Highway Extension and Research Project for Indiana Counties and Cities (HERPICC) at Purdue University [1]. Limited funds and other resources available to most local authorities make it impossible for all unpaved roads to be paved or surfaced. Most counties and cities with unpaved roads will benefit from unpaved road maintenance procedures outlined in this guide.

DEFINITIONS

The term "unpaved" has been used in this manual to describe unimproved roads, graded and drained roads, and roads with surfaces of natural earth, gravel, aggregate or stone. In contrast, roads with bituminous mix or surface treatment (chip and seal), cement concrete or brick surfaces are "paved". Unpaved roads are sometimes called "unsurfaced" roads.

For reporting road inventory information in Indiana, three main unpaved road classes are defined as follows:

Unimproved Road: A road composed wholly, or apart from a few local exceptions, of the natural ground of the region traversed. The alignment, grade and drainage may not be up to the standard of a "graded and drained" road (see definition below). The Highway Department is required to ensure that such roads are passable only.

Graded and Drained Road: A road with a natural earth surface that has been aligned, graded and provided with longitudinal or transverse drainage. The drainage may be natural or artificial, to prevent serious erosion by surface water.

Gravel or Stone Road: An unpaved road that may be well-aligned and drained, with a wearing surface consisting of quarry produced or natural limestone or other gravel, broken stone, slag, chert, caliche, iron ore, shale, chat, disintegrated rock or granite, or other similar fragmental material (coarser than sand). In Indiana, crusher-run #53 and #73 aggregate or #5, #8 and #9 have been used on unpaved road surfaces. The first two materials, #53 and #73 aggregate, are used
as crushed stone base for paved roads. Gravel or stone roads are sometimes called aggregate surfaced roads.

**MILEAGE DISTRIBUTION OF COUNTY UNPAVED ROADS**

Out of a total of 68,297 miles (1982 IDOH Certified) of road maintained by County Highway Departments in Indiana, 41 percent is unpaved. Figure 1 shows the percentage of total county maintained road miles that are unpaved in each of the 92 counties in Indiana. Apart from four counties, which have recorded negligible unpaved road mileage (less than 10 miles) and eight with less than 100 miles, every other county is responsible for over 100 miles of unpaved roads.

![Map of Indiana showing percentage of unpaved roads](image)

**Figure 1.** Percentage of county maintained road miles that is unpaved in Indiana. (Source: 1985 Annual Reports)
UNPAVED ROAD DETERIORATION CHARACTERISTICS

Because unpaved roads change condition quickly, they require more frequent inspection and maintenance than paved roads. Road condition is affected by many factors, including: traffic volume, weather, vertical and horizontal road alignment, surface material used, drainage, and the maintenance and reconstruction practices of the highway department. Road surface distresses show the condition a road is in. An understanding of these distresses, which worsen when no maintenance is performed, can help in maintaining unpaved roads.

TYPICAL DISTRESSES ON UNPAVED ROADS

Typical surface distresses that occur on unpaved roads are described in this section.

Corrugation or Washboarding

Corrugation consists of waves or ripples perpendicular to the direction of vehicle travel (Figure 2). Average wavelength (distance between crests or troughs) of

![Figure 2. Corrugations on unpaved road surfaces.](image-url)
corrugations ranges from about 17 in. to about 48 in., with trough depths from 5/8 in. to 1-1/4 in. Corrugations often occur at road approaches to intersections, on sloping road sections with driveways, and at approaches to curves, bridges and other culverts. In general, corrugations are likely to form rapidly at locations where drivers slow down, stop or accelerate. The shoving action from locked vehicle wheels after braking as well as vehicle vibrations contribute to corrugation. However, improper blading techniques can also lead to corrugation when fine materials are blown away as dust with the wind or washed away with water erosion. Unpaved roads with loose, uncompacted, coarse materials usually experience more corrugation.

**Wheel Ruts**

Ruts (Figure 3) occur along the wheel paths of vehicles as a result of continuous localized compaction, polishing and whip off, or displacement of larger sized particles. Ruts are deepened by rains as well as by vehicular traffic. In general,

![Figure 3. Deep wheel ruts form on unpaved road surfaces- In this example, surface stone is depleted and the subgrade is rutted.](image)

finer surface material will rut more. However, coarser surfacing materials do not resist surface moisture penetration. They retain moisture for longer periods of time, which affects finer moisture susceptible materials below the surface, hence with traffic, they also tend to rut. A deep rut of more than 2-3 inches is a sign of a
failing road pavement. At the initial stages, identifiable wheelpaths provide smoother vehicle running surfaces. However, as ruts get deeper, they create an uneven driving surface.

**Potholes**

Potholes (Figure 4) on unpaved road surfaces are more visible after a rain.

![Figure 4. Potholes on an unpaved road surface.](image)

These localized holes in the surface can form in areas where corrugations started but did not extend across the entire road width. They can also result from a localized vehicle rut in a location with a weak surface or subgrade over which vehicles have passed when wet. Potholes are a problem when they become widespread or deep and result in a rough or uneven ride.

**Surface Gravel or Stone Loss**

Loss of gravel or stone from the surface of unpaved roads results mainly from traffic. However, wind, rainfall, and grading also contribute to gravel loss as more surface stone is exposed and subjected to whip-off action from vehicle tires. Gravel loss leads to a reduction of pavement strength owing to the reduced depths of gravel surfacing and the potential exposure of finer subgrade material. The latter condition can accelerate the formation of ruts and potholes. A rule of thumb is that surface gravel depth is lost at a yearly rate of 1 inch for every 100 vehicles per day traffic. Hence, an unpaved road carrying 100 vpd would reduce its surface gravel or stone depth by 4 inches in a period of 4-years, in general [2].
Gravel Looseness

Loose gravel on unpaved road surfaces (Figure 5) result from the use of predominantly coarse and uncompacted surface gravel or stone. With traffic, loose stone is moved towards the center and roadsides. The road surface becomes uneven, resulting in a rough ride. There is also potential for windshield damage from stones whipped off by tires of leading or passing vehicles.

Dust Generation

The discomfort and inconvenience of dust emission from unpaved surfaces is most serious when roads with higher volumes of traffic are near residential areas or farms and other properties. The loss of fines from blowing dust is caused largely by moving vehicles and wind (Figure 6). Special studies of dust generation showed that nearly
all the airborne fine material dislodged from roads fell within 25 ft of the road edge, with about 60 percent falling within 9 ft. Up to 100 tons of fine material per mile could be lost annually with average traffic speeds of 20 mph and higher [1]. Dust control procedures are described in Section 3.4.

**Surface Erosion**

Erosion of unpaved road surfaces is the direct result of rainfall and surface running water (Figure 7). Erosion is increased when surface material is loose and uncompacted; when the crown and camber is insufficient for drainage; side
ditches or culverts are non-existent or blocked or side berms have been created on the roadsides by accumulated loose material and frequent cutting by grader blades.

![Figure 7. Surface erosion on an unpaved road. Erosion can be as serious as in this picture with the formation of several secondary ditches in the road surface.](image)
UNPAVED ROADS MAINTENANCE TECHNIQUES

Distresses described in Chapter 2 show how unpaved road condition deteriorates. The condition can be improved with proper maintenance which include the following activities:

Surface Maintenance Activities
- Smoothing by Dragging or Blading - Routine Maintenance
- Grading involving reshaping - Periodic Maintenance
- Adding Surface Gravel or Stone - Periodic Maintenance
- Dust Control and Stabilization - Periodic Maintenance

Drainage and Other Maintenance Activities
- Drainage Maintenance - Routine Maintenance
- Vegetation Control - Routine Maintenance
- Snow Plowing and Control - Seasonal Routine

Routine maintenance activities are those performed frequently (often on a daily basis) within a year. Periodic maintenance activities are required once or twice a year, depending on road condition, and can involve major maintenance or repair of existing unpaved roads.

SMOOTHING BY DRAGGING OR BLADING

Dragging or blading is performed to smooth the road surface. The equipment used determines whether it is called dragging or blading. Dragging uses a drag or "maintainer", which is towed by a tractor (Figure 8). The typical drag used in Indiana is made with small blades attached to a metallic frame as in Figure 9 to provide a smoothing action and also pull loose material from the sides towards the center of the road. Drags can also spread windrowed material on the surface to fill surface irregularities. Dragging restores an existing undisturbed surface crown through a smoothing action that does not involve cutting of the surface crust.

Blading is similar to dragging but a motorgrader (Figure 10) or truck with an underbody blade (Figure 11) is used. The moldboard is tilted forward to apply light downward pressure on the grader blade to minimize disturbance of the
Figure 8. Tractor-towed maintainer used for dragging unpaved roads.

Figure 9. Close-up view of the maintainer showing the frame and blades.

Figure 10. A motor grader is also used for blading, grading and spreading material.

Figure 11. A truck with mounted underbody blade is also used for blading and grading.
surface crust (Figure 12). The angle of the moldboard should be adjusted to

1. Deep cutting in grading of road surfaces.
2. Light cutting for light grading.
3. Position for blading or dragging action on road surfaces.

Figure 12. Grader blade pitch adjustments for varying the depth of cutting.

between 30 and 45 degrees (Figure 13). The front wheel of the motorgrader should be tilted or leaned slightly 10 to 15 degrees toward the direction in which the gravel or stone is expected to roll. The speed of the grader depends on the type of grader, the blade’s angle and the road condition. Too much speed tends to make the blade bounce and can lead to washboarding or corrugation on the road surface. A suggested safe speed is about 3 miles per hour in second gear [3], although speeds up to 5 miles per hour have been used.

**Corrugations, Weather, and Surface Crust**

Dragging or blading is sometimes not effective for correcting deeper corrugations, ruts or potholes (more than 2 in. deep). Frequent passes of the drag or motorgrader are required to produce a smooth road surface, especially on roads with higher volumes of traffic.
Figure 13. Grader moldboard position for blading or grading. Three passes are usually required. One on each side of the road surface. A windrow is created in the middle which is spread during the third pass.

A commonly accepted practice is to blade or drag roads after rainfall when the surface gravel or stone and fines are moist and will provide a lasting binding action. Caution should be exercised when blading or dragging in dry weather since fine material can easily be lost from the road surface. When long periods of dry weather occur, blading operations can be used to recover loose coarse and fine surface material and store in windrows on the side. The material can be respread on the road surface after a rain.

Correct blading or dragging promotes the formation of a surface crust when properly blended coarse and fine stone dry and form a crust. ONE SHOULD NOT DELIBERATELY BREAK SURFACE CRUST BUT AIM AT RESPREADING SURFACE MATERIAL DURING BLADING OR DRAGGING.
Blading over Hilltops

When blading over a hilltop, the operator must avoid cutting the crest off. As the front and rear of the wheels of the motor grader pass over the hilltop, the blade must be adjusted up, then down again. A lower gear should be applied going downslope to reduce the bounce in the blade that could lead to washboarding. Only a small pressure should be applied on the blade to reduce the amount of surface material removed. The above action will prevent the material removed from being deposited in the valley below and also prevent the occurrence of a slick slope when it rains [4].

Blading Valley Bottoms

Grader blades should be controlled at the valley bottom to avoid improper accumulation of material or excessive cutting. The blades should be raised as the front wheels cross the low spot and begin to move up slope.

Frequency of Blading/Dragging

Blading frequency can vary from twice a year to once every seven days, depending on traffic, and local resources. An unpaved road surface can revert to its original level of roughness 20 days after blading. Consequently, weekly blading may only be justified for roads with higher traffic volumes, preferably over 100 vehicles a day. The road surface roughness, average rut depth and rate of corrugation determine whether grading should be undertaken more frequently. Gravel roads on hills and with locations where traffic slows down, stops or accelerates (for example, intersections and curves) tend to develop corrugations more rapidly and require more frequent blading or grading as described in the next section. Blading frequencies for various levels of traffic volume are presented in Table 1.

Table 1. Suggested grading frequency for various ADT ranges, likely costs per mile and other actions.

<table>
<thead>
<tr>
<th>Traffic Volume (vpd)</th>
<th>Grading Frequency Days Between (#Times/Yr.)</th>
<th>Annual Cost/Mi (1982)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50</td>
<td>40 - 60 (7 - 5)</td>
<td>$150 - 108</td>
<td>Roads with steep grades. Frequent Corrugation may require maximum freq.</td>
</tr>
<tr>
<td>50 - 100</td>
<td>21 - 40 (13 - 7)</td>
<td>$280 - 150</td>
<td>Same as above including locations with frequent driveways</td>
</tr>
<tr>
<td>100 - 200</td>
<td>7 - 20 (40 - 13)</td>
<td>$860 - 280</td>
<td>Same as above some dust control may be required</td>
</tr>
<tr>
<td>&gt; 200</td>
<td>7 or less (&gt; 40)</td>
<td>&gt; $860</td>
<td>Same as above. Consider Stabilization or Paving</td>
</tr>
</tbody>
</table>

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GRADING

Grading is like blading except that some cutting may be necessary during the operation. The grader moldboard is tilted backward with sufficient down cutting to produce a cutting action as opposed to the forward tilt for blading or dragging. Road surface material is cut from the sides inward for blending and spreading. The usual practice is to make three basic passes with the grader - one pass in each direction creating a windrow in the middle followed by a final pass over the middle to spread the material. More passes are required if greater reshaping is required. In locations with deeper corrugations or potholes, the road surface may need to be scarified or broken up, preferably when the surface is moist.

DRAINAGE MAINTENANCE

Surface drainage maintenance is a part of the grading or blading operation. Most washouts occur because of improper road surface drainage.

Crown and Cross-Slope

The main aim in road surface maintenance is to provide a suitable crown by grading the roads higher in the middle than in the sides. A good crown prevents water from being trapped in the middle and creating conditions for erosion and formation of potholes and ruts. Good surface drainage requires a crown with cross-slope of between 3/8 inch to 3/4 inch per foot of road width measured from the centerline. The best shape of cross-section is like a flat letter "A" rather than a flat circular top (Figure 14). A cross-slope of 5/8 inch per foot (5%) or less is preferred on unpaved roads carrying traffic volumes of more than 100 vehicles per day with higher operating speeds up to 55 mph. Slopes as low as 1/4 in. per foot may be satisfactory if the material used is sufficiently stable. A water-tight road surface material ensures adequate transverse drainage over the road surface. Crown can be measured by using a "crown gauge" or slope meter mounted on the motorgrader.

Special Considerations in Blading or Grading a Crown

At Road Intersections

Where two unpaved roads intersect, the surface crown on each road should be gradually eliminated. This should start about 50 to 100 feet away from the intersection. If the road intersecting the one being graded has a stop sign, the crown should be retained across the intersection.
If the intersecting roadway is paved, the crown should be eliminated starting about 100 feet from it. The operator has to avoid spreading loose material onto the paved road. If this occurs, and it is safe to do so, the operator may reverse and pull material back onto the gravel road. Otherwise, a shovel or brush may be used. The gravel road being graded or bladed must be maintained at the same grade as the paved road at the point of intersection.

At Railroad Crossings

The crown must again be gradually eliminated on either side of the railroad tracks with no crown at the point of intersection. The operator has to avoid blading gravel or stone onto the crossing. Stones wedged between the flanges cause derailment. A hand shovel or brush is appropriate for removing loose stone at the crossing.
At Bridge Approaches

The crown of the unpaved road approach to a bridge must conform to the crown on the bridge surface, if any. For most wooden bridges, a flat bridge surface is maintained; hence, the crown should be gradually eliminated towards the bridge. The operator has to ensure, always, that the road level is the same as that of the bridge deck at the point of intersection.

At Driveways

Although driveways are of less importance, the grader operator or dragman must ensure that there is no drop from the road edge on the driveway or from the driveway onto the graded road. The road edge and the driveway entrance should be at the same elevation.

At Curve Approaches

The road cross-section at a horizontal curve is superelevated (Figure 15). At the

Superelevation Should Be Maintained on Roadway Curves During Grading and Reshaping of Gravel Road Surfaces

Figure 15. Typical road cross-section on a curve.

curve, the shoulder should be graded and sloped downward from the edge of the superelevated road width into the foreslopes on both sides of the road. When grading towards a curve and away from it, the original crown should be gradually eliminated or reintroduced. This should be done within 100 feet of the curve.

Shoulders

Although shoulders are not always provided on unpaved roads less than 24 ft.
wide, vegetation and plant growth on the unused part of the roadway create shoulders. In addition, side berms are formed by accumulated material dispersed by traffic, frequent blading or dragging, or continued grader cutting over the roadbed only and not over the entire roadway width. Secondary ditches can be created as a result of this condition, especially during a rainfall when water runs over the road surface. Such ditches in the roadway (Figure 13) should be promptly reshaped to ensure good surface drainage.

A motorgrader or a truck with mounted underbody blade can be used to reshape the shoulder or cut side berms (Figure 16). When dragging or blading, the

![Image](image_url)

a. Side berm about 10 in. deep created after continuous grading of a gravel or stone road surface.

b. Side berms being cut to restore cross-section for proper transverse drainage.

Figure 16. Maintenance of side berms on unpaved road sides.

shoulder and the side berms should be reshaped periodically. Aggregate and fines can be recovered and used on the surface while unwanted vegetation is removed. The shoulder slope should be the same or preferably greater than the roadbed’s cross-slope to ensure that water will drain to the foreslope into the side ditches. To achieve this, the grader blade should be adjusted so that the inside edge of the "shoulder" is at the same elevation as the outside edge of the road surface.

**Side Ditches**

Cleaning and recutting side ditches to remove or recover accumulated coarse aggregate and fines and other debris make up the final stages in drainage maintenance. Reshaping can best be carried out using a motorgrader or a
"Gradall". Using the motorgrader, the side slopes should not be steeper than 3:1 (Figure 17) to accommodate the tilted blade and produce an effective cutting action [5].

a. Cutting side ditch with a motor grader (this has been difficult to use on most county roads because of limited right-of-way).

b. Cutting a side ditch with a Gradall (common practice in Indiana).

Figure 17. Cutting side ditches on unpaved roads.

Culverts

Culverts provide essential cross-drainage and should be regularly inspected and cleaned after stones, top soil and other debris accumulate in them. A blocked culvert, in spite of a well-maintained roadway and side ditches, could cause a localized washout (Figure 18).

Figure 18. Transverse erosion at a location on an unpaved road without a culvert.
DUST CONTROL AND STABILIZATION

Dust control is required mainly to keep fine, binder aggregates bound to the surface. Calcium chloride and magnesium chloride have commonly been applied as dust control agents. Both materials absorb moisture into the soil binder. Sometimes liquid asphalt or road oils have also been used. Sprinkling with water provides only a temporary solution but is often a rapid method, especially where suitable agents are unavailable or expensive.

Calcium chloride, most often used, may be applied in flake or liquid form. Liquid calcium chloride can be applied at a rate of about 0.3 gallon per 5 square yards in the spring, followed by about 1.0 gallon per 5 square yards during the summer. Calcium chloride in flake form is applied at 1.2 pounds per square yard in the spring or 0.8 pound per square yard for the second application. Continuous application of calcium chloride tends to stabilize the surface material and produce a hard crust.

Frequency of Application of Calcium Chloride

The frequency of application depends on the local agency’s available resources, particularly money. Some counties in Indiana undertake dust control operations paid for by residents living adjacent to unpaved roads.

Asphalt Materials Application

Asphalt emulsions and cutbacks have been used for dust control. Medium cure (MC) cut-backs are applied in one application at a rate of 0.25 to 0.3 gallon per square yard on well bladed or graded and compacted unpaved road surfaces. In other cases, slow setting emulsified asphalts have been diluted with about five parts of water to one part emulsion and lightly applied at rates from 0.1 gallon per square yard to 0.5 gallon per square yard.

A more permanent but also more expensive solution to the dust control problem is the single or double coat surface treatment or "chip and seal" (Figure 19). Most counties, however, undertake less than 5 miles a year of surface treatment. Extreme care is required to ensure that the existing gravel or stone surface is well prepared and adequately compacted before applying surface treatment. Experience from Alaska showed that for high-speed unpaved roads, a well-prepared gravel or stone base resulted in economically justified surface treatment; otherwise, the more economical alternative was to leave roads unpaved [6].
A DDITION OF SURFACE GRAVEL OR STONE

 Spot Regraveling

It is essential to replace lost gravel or stone material from unpaved road surfaces (Figure 20). Addition of gravel or stone is a periodic maintenance activity;

however, many counties apply lesser quantities of gravel or stone for localized or spot regraveling in routine maintenance as needed during the year. The entire roadway need not be disturbed to correct occasional potholes on an otherwise sound gravel surface. Instead, the holes can be patched with a 50/50 mixture of crushed gravel and calcium chloride, sprinkled with water and tamped. Also, during spring thaw and other muddy seasons, quality gravel with adequate coarse and fine sizes should be used instead of sand, to correct problem wet areas.
Regraveling with Reshaping and Compaction

As a general rule, with a rate of gravel loss of 1 inch for every 100 vehicles per day traffic, an unpaved road carrying 100 vpd which has received only spot additions of gravel or stone to the surface will require an additional thickness of 4-inches every four years. This thickness increases as traffic volume on the road surface increases.

The applied layer of gravel or stone should be at least twice the thickness of the largest stone size. Hence, with a 4-inch gravel or stone course, the largest stone should be 2 inches or 3 inches for a 6-inch layer.

Regraveling may require reshaping of the existing road surface before application of gravel or stone.

Surface Material Specifications, and General Practices

The type of gravel or stone used on an unpaved road surface affects the performance of the road. Indiana highway specifications [7] suggest the use of Indiana No. 53 and No. 73 stone (Figure 21) as base course material for paved roads. However, some Indiana counties have used No. 5, No. 8 or No. 9 stone (Figures 22). Sometimes, stones larger than 2 inches have been detected in surface material samples. Roughness on roads with the larger stones was higher than roughness on roads with mainly No. 53 or No. 73 stone, although the material may have been slightly modified with use.
Percent Fines, Liquid, and Plastic Limits

Indiana specification for unsurfaced gravel or stone roads is that liquid limit should not exceed 25 (35 if slag is used) for the fraction passing No. 40 sieve. In addition, material passing No. 200 sieve (the fines) should be between 5 to 12 percent and the plasticity index should not exceed 7. Gravel or stone samples collected from unpaved road surfaces lacked sufficient binder fines with plasticity indexes of at least 7 [1].

Desirable Surface Material Characteristics

Desirable characteristics of a gravel or stone road surface include a well-graded aggregate structure with adequate fines that provide a cohesive binder to bond the aggregate in place. The result, with compaction, is a stable, waterproof surface that can be easily maintained. Maximum aggregate particle size should be held to about 1 inch to minimize "raveling" and make blading easier. Quarry screens (Figure 23) and fine clay binder material can be added to predominantly coarse material on the road surface to improve the stability. If larger aggregate sizes are present, they can be scalped or crushed. In general, larger stone sizes can be used as subbase material before applying base type material on the surface.

Material for Corrugated Locations

High quality gravel or stone as described in the specifications, well compacted to
achieve a tight, strong surface, can be used to replace material in locations susceptible to corrugation if soil quality appears to be poor. The need for under drainage should also be investigated at such locations.

**Vegetation Control**

Grass growing on shoulders or surface of unpaved roads can be removed during grading. However, at some locations shrubs and tree branches should be controlled with periodic cutting to improve visibility and safety.

**Snow Plowing and Frost Considerations**

Snow plowing on unpaved roads in the winter depends on the priority given to access to the areas served by such roads. School bus routes and roads carrying higher traffic volumes are often given higher priority. In general, except after major snowstorms, most unpaved roads remain passable during the cold season, with the surface mostly in a hard frozen state. Light snow falls can be removed with a heavy motor grader. Heavier snow falls may, however, be removed with a snow plow. Snow left on the road is packed down by vehicles and may freeze making removal slower and more difficult. On most low-volume gravel or stone roads, the frequency of maintenance is often dictated by cost, social and other considerations. Snow fences can be erected in places where drifts occur frequently. Problems occur during spring thaw when ruts begin to form as a result of wet surface material and subgrades. Frequency of snow plowing depends entirely on the weather.
MANAGEMENT PROCEDURES FOR LOCAL UNPAVED ROADS

INTRODUCTION

Unpaved roads are often managed on an ad hoc basis because of their low traffic volumes and often low assigned priority in a local network, as well as the rapid condition changes they experience. A highway department can easily resort to emergency maintenance procedures on unpaved roads. With scanty and indiscriminate record keeping in some counties, it has often been difficult to isolate the cost of unpaved road maintenance and repair. Some organizational procedures are discussed in this chapter of the manual.

CURRENT COUNTY OR CITY ORGANIZATIONAL PROCEDURES

Indiana counties or cities have adopted many different methods for managing unpaved road maintenance, especially in assigning responsibility for dragging, blading and grading operations, as follows:

Organizational Procedure One

Equipment operators are assigned graders, maintainers or drags and roads in demarcated areas or districts in the county. They operate daily to and from their homes following a schedule based on their personal knowledge of the road network for which they are responsible. The exact pattern of road locations worked may often not be recorded or known to the Road Supervisor. Daily assignments can be changed from prepared programs or emergency requests made by the Road Supervisor or Engineer. All equipment operators and drivers often have radio contact with the highway garage.

Most operators are responsible for minor maintenance or service of their equipment. This procedure can be convenient for management but leaves the responsibility for the condition of roads solely in the hands of the grader operators or dragmen.

Organizational Procedure Two

In this procedure, operators are assigned grading or dragging equipment and areas of responsibility in the county but report daily to the highway garage for instructions or consultations with the supervisor or to clock in for work. If
considered safe, equipment may be parked at convenient locations for the next
day's work or returned to the garage as appropriate.

In almost all counties, no recorded information on patterns of grading is
maintained. Individual operators know the details of the locations of work done.
Regular contact is usually maintained with the Road Supervisor who may be
aware of the location of all daily grading activities.

**Organizational Procedure Three**

In a few counties, no special assignments are made for unpaved road
maintenance. Road maintenance personnel can be assigned responsibility for
road sections and maintenance activities on any part of the road network. Work is
assigned daily or sometimes weekly by the Road Supervisor, Engineer or
Foreman at the highway garage. Priorities are determined by the Road
Supervisor or Engineer.

**Considerations for Reorganization**

Each of the above methods has its own merits but coordination with the Road
Supervisor is essential for effective maintenance and planning. For effective
monitoring of maintenance activities and costs as well as planning of future major
maintenance or rehabilitation work, proper record of maintenance activities
should be kept. Most counties use accounting procedures outlined by the State
Board of Accounts in a Cost Accounting Guide published by HERPICC [8].

Several approved bookkeeping forms have to be kept manually by the County
Highway Clerk or Bookkeeper. The detail of records maintained varies from
county to county and a few county highway departments have either acquired or
made plans to acquire a microcomputer. HERPICC is preparing a supplementary
highway management manual with an accompanying microcomputer software
program package to enable the average county to keep its cost records and
accounts by maintenance activity and road surface type.

**Frequencies for Dragging or Grading Unpaved Roads**

Unpaved road deterioration increases as traffic volume increases; hence,
frequency of maintenance should be related to traffic volume. Based on initial
research by HERPICC [1] conducted in Indiana counties, Table 1 presents
suggested unpaved road dragging or grading frequencies based on traffic
volumes. Traffic volume should be measured by the highway agency; however,
for initial maintenance planning, estimates based on experience can be made. The values should be confirmed or revised from traffic volume counts later. Most counties have taken advantage of traffic counting equipment lease through HERPICC, although counts have mostly been made on paved roads. To improve total road surface management, traffic volume counts should cover all road surfaces.

**Daily Dragging or Blading Schedule**

Daily schedules for dragging or blading can be prepared on area or district road maps based on the suggested frequencies in Table 1. An example of patterns of dragging operations has been shown in Figure 24. Using the daily patterns, road

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Figure 24. A typical pattern of daily dragging or blading by one operator in a county highway department.
sections may be omitted or added if they require less or more frequent dragging, respectively. Such patterns can be developed by the operator in consultation with the Road Supervisor and the Highway Clerk. Information on individual road sections can be recorded for cost accounting purposes from the established patterns reported daily by equipment operators including any road section additions or deletions. Modifications to the established patterns will be necessary only if road maintenance policy is modified or road condition changes drastically.

**ROAD INSPECTIONS AND CONDITION SURVEYS**

Drag or grader operators should regularly report unusual conditions observed on unpaved road sections. If considered serious, this condition may be confirmed by the foreman or Road Supervisor and remedial action taken. Annual road inspection should be conducted in the spring to determine major maintenance needs including spot or total surface gravel or stone addition. Special road condition surveys will be required when paving or reconstruction is being considered. Selected road condition procedures have been presented in FHWA's report on Local Road Surface Management [9]. Table 2 presents decision criteria based on a serviceability (road condition) rating system examined in studies by HERPICC [1].

Table 2. Suggested road surface management options for various PCR and PSR.

<table>
<thead>
<tr>
<th>PCR (PSR)</th>
<th>SPEED (mph)</th>
<th>ROUGHNESS (Counts/Mile)</th>
<th>MANAGEMENT OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 (3.5)</td>
<td>&gt;40</td>
<td>-</td>
<td>500 No Maintenance</td>
</tr>
<tr>
<td>2.0 (3.0)</td>
<td>&gt;40</td>
<td>1000</td>
<td>1500 1250 Blading</td>
</tr>
<tr>
<td>2.5</td>
<td>36</td>
<td>2000</td>
<td>3100 2100 Grading</td>
</tr>
<tr>
<td>3.0 (2.0)</td>
<td>30</td>
<td>3000</td>
<td>2900 Heavy Grading and Regraveling if Required</td>
</tr>
<tr>
<td>3.5 (1.5)</td>
<td>&lt;28</td>
<td>4000</td>
<td>3700 Regraveling</td>
</tr>
<tr>
<td>4.0 (1.0)</td>
<td>&lt;26</td>
<td>5000</td>
<td>4600 Rehabilitation (Condition Survey)</td>
</tr>
</tbody>
</table>

**NOTES**

- Representative of Southern Counties with Rolling to Hilly Terrain (Typical Material Used is Indiana No. 5, 8 or 9)
- Unstable Subgrade Soils of “Muck or Peat”
- Representative of North Central Counties with Flat to Rolling Terrain (Typical Material Used is Indiana No. 53 or 73)
SUMMARY
SUMMARY GUIDELINES FOR UNPAVED ROADS
MAINTENANCE MANAGEMENT

In this section, detailed guidelines in Sections 1 to 4 are summarized for county or local area unpaved road maintenance management.

ESSENTIAL MANAGEMENT PROCEDURES

The following actions are required for efficient management of unpaved roads.

1. **Conduct a road inventory** to identify the locations, mileage, alignment, widths and surface material types of unpaved roads in the local road network. The IDOH county road inventory information can be updated by relating to local road names.

2. **Prepare a suitable road map** showing the various road surface types maintained by the highway department. Update the map when changes occur after reconstruction or resurfacing.

3. **Determine unpaved road dragging or grading frequency** using Table 1. The frequencies can be increased for roads with steep or rolling gradients and/or many intersecting roadways. (NOTE: Such locations may experience severe corrugations often.)

4. **Develop suitable network of road links for daily dragging or grading** by individual operators using specified dragging frequencies. See example in Figure 24. Road sections to be graded less often can be omitted as required.

5. **Conduct road surface inspection frequently.** Dragmen and operators should also report serious deteriorating road conditions. Special condition surveys are required if major improvements to unpaved roads are planned.

6. **Indiana State Board of Accounts guidelines for county highway accounting** [9] should be followed. This will ensure that unpaved road maintenance costs are accurately estimated as part of total road network costs.

UNPAVED ROAD MAINTENANCE TECHNIQUES

The following maintenance activities are essential for proper unpaved road maintenance.

*Dragging or Blading*
Drag to smooth the road surface and to pull surface material from the sides to the road center. Three passes may be required - one each down the sides and one in the middle to spread material. Do not cut the surface crust. Drag after rain and recover loose material during long dry periods.

**Equipment**
- Tractor-towed drag or maintainer; truck with underbody blade; light motor-grader.

**Special Operational Practices**
- Tilt moldboard forward
- Angle of moldboard should be tilted 30-45 degrees
- Lean front wheels 10-15 degrees towards direction expected to roll
- Maintain a speed of about 3 mph

**Special Considerations-Hilltops, Slopes, and Valleys**
- Do not cut deep over hilltops. Adjust blade up, then down again
- Use lower gear downslope applying a small pressure only
- Avoid excessive material accumulation or down cutting at valley bottoms

**Grading**

Grading requires more surface or crust cutting than when dragging or blading. More passes may be required.

**Equipment**
- Truck with underbody blade - light grading only. Motorgrader - for light and heavy grading.

**Special Operational Practices**
- Tilt the moldboard backward for down cutting

**Special Considerations**
- Same as for dragging or blading.

**Drainage Maintenance**

**Crown and Cross-Slope:** Maintain a crown for proper drainage during dragging or blading and grading. Cross-slopes from center to the sides range between 3/8 - 3/4 inch per foot of width, low cross-slopes of 1/4 inch per foot may be satisfactory if the surface material is sufficiently stable.

**Equipment**
- A crown-gauge or slope meter can be mounted on the motorgrader.
Special Considerations
- Do not leave a furrow in the roadway
- Avoid double ditches

At Road Intersections
- Gradually eliminate the crown from 50 to 100 ft. towards the intersecting road.
- Retain the crown across if the intersecting road has a stop sign and the graded road does not.
- Do not spread gravel on an intersecting paved road.

At Railroad (RR) Crossings
- Gradually eliminate the crown on either side of the RR line (50-100 ft.)
- Do not blade gravel or stone onto the rails. Brush off excess gravel from rails.

Bridges
- If the bridge has a crown, maintain the same crown on the road. Otherwise, eliminate crown gradually on either side (50-100 ft.)

Driveways
- Avoid a drop from driveway onto the bladed road and vice versa.

Curve
- Within a 100 ft. of the start of the curve, gradually eliminate the crown to achieve superelevation on the curve.

Shoulders
- Side berms created by continued cutting at the sides or accumulation of material on the sides should be avoided.
- Shoulders and berms should be reshaped periodically during dragging and blading.
- Avoid secondary ditches.
- Shoulder slope should be the same or steeper than the roadway cross-slope.

Side Ditches

Side ditches should be cleaned and recut periodically to recover accumulated aggregate and maintain side drainage.

Equipment
- Motorgrader (less than 3:1 side slopes), backhoe or "Gradall".
**Culverts**

Inspect and clean culverts periodically to avoid blockage.

**Dust Control and Stabilization**

Continus calcium chloride application will tend to stabilize and help to form a hard surface crust.

**Liquid**
- 0.3 gal per 5 sq. yards in Spring
- 1.0 gal per 5 sq. yards in Summer

**Flakes**
- 1.2 lb per sq. yard in Spring
- 0.8 lb per sq. yard second application

**Addition of Surface Gravel or Stone**

Gravel or stone may be added periodically to the road surface as needed by spot-regraveling. Potential locations are:
- After spring thaw, to strengthen weak areas
- After a heavy rainstorm to replace lost material
- Locations with loose surface gravel or which are badly potholed or corrugated.

A fresh (4-6 inch) layer of gravel may be added every 4 years if gravel or stone thickness is lost.

**Equipment**
- Motorgrader for spreading or with ripper for scarifying if required; dump trucks for haulage of material. Roller if required.

**Materials**
- Indiana No. 53 or No. 73 may be applied or where loose coarse material abound, screens may be added to replace sands and fines.
- No. 5, 8 and 9 stone may be applied as subbase otherwise, the surface is usually rougher.

**Surface Treatment or Chip and Seal**

Unpaved roads may be "chip and sealed" only after adequate preparation of the existing surface as base. Otherwise, it is more economical to maintain the road surface as unpaved.
Vegetation Control

Cut to control excessive shrub growth, as needed on low-volume unpaved road surfaces to avoid reduction of effective road-widths and sight distances.

Snow Plowing and Winter Maintenance

Snow should be plowed on unpaved roads as required. It may not be necessary to drag or grade unpaved roads during winter periods when roads are frozen unless the road surfaces thaw.
OTHER RESOURCE MATERIALS FOR REFERENCE


