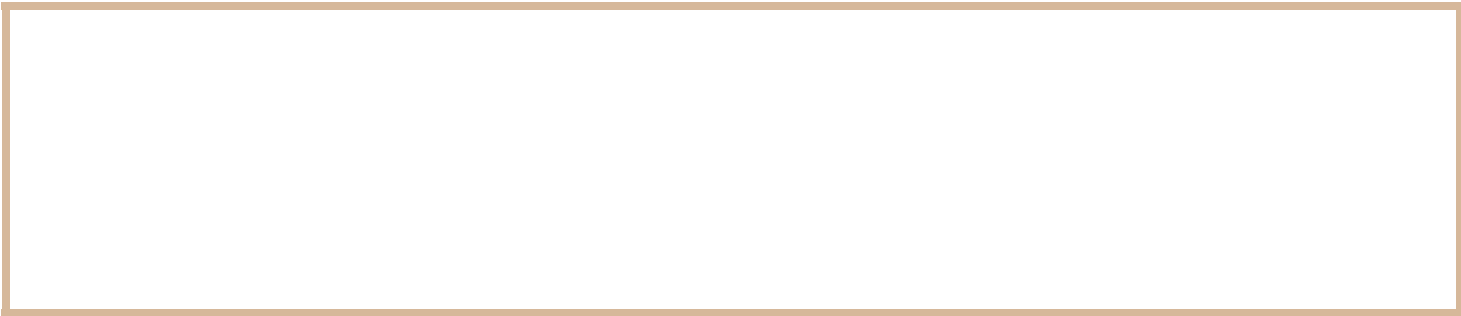


Rural Home Technology

Presented by Russ Lanoie



Road & Driveway Maintenance

Wet Basements

Septic Systems



A Ditch in Time:

Introduction:

Ruts, bumps, potholes, mud, washboard and dust make unpaved rural roads

uncomfortable and sometime even impassable for the motorists who use them. It's the washouts that occur along with these inconveniences that create a greater long-term problem, however.

Although only certain roads provide direct access to ponds, lakes, and streams, the runoff from *all* roads eventually finds its way to surface water. Unstable roads become channels through which sediments and nutrients reach sensitive lakes and ponds, causing significant adverse effect on water quality. Increased lakeshore development requires additional roads and driveways for access.

In the old days, back before any country roads were paved, landowners often played an active role in their care. They understood that a few minutes work with a hoe at the beginning of a rainstorm could get the water off of a road and keep wheel ruts from turning into deep gullies. **A Ditch in Time**...(with apologies to Poor Richard) implies that there are still basic maintenance steps that can be taken to prevent major damage from occurring to our many remaining miles of "dirt roads". Most of these steps still have to do with controlling water, from getting it off and away from the road to choosing materials that can work well in the presence of too much water and, at times, in its absence.

This discussion is intended to help you evaluate all unpaved roads and implement a program to improve them. A properly planned and well-executed maintenance program not only makes the road more comfortable to travel on, but also reduces maintenance costs over

time. More importantly, it also reduces the impact of erosion on fragile lakes and ponds, helping to preserve these splendid resources and the special qualities that attract us to them.

NOTE: A Ditch in Time is based substantially on information provided through the federally and state DOT sponsored Transportation Technology Transfer Centers. While it began as a rewrite of the original "Maine Camp Roads Manual," it grew to also include much of what I've learned during my 30 plus years of road and driveway construction and maintenance. I have presented it in workshop format throughout northern New England in conjunction with the development of the Front Runner grader/rake system.

For quick reference regarding a particular road problem, look at the [Gravel Road Troubleshooting Guide](#).

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1.0 CAMP ROADS AND THE HYDROLOGIC CYCLE

Water falls to the earth in various forms of precipitation. Upon contacting the earth this water tends to run downhill over the surface of the ground to a body of water (lake, pond, stream, etc.) ultimately reaching the sea. A portion of this water will soak into the ground and run underground until entering surface water. At some point the water will evaporate back into the atmosphere and return to earth again in the form of precipitation. This cycle is continuous and eternally repeats itself, as shown in Figure 1.

Roads alter and interfere with the drainage patterns that feed our lakes and ponds by creating obstructions to the natural flow of water. Properly built roads allow subsurface water to drain naturally, but the very nature of roads tends to restrict and channelize surface water flow. A primary goal in camp road maintenance should be to limit any detrimental effects caused by this flow of water. Therefore, any maintenance program must be built on a thorough understand of the three principles of road design and maintenance: drainage, drainage, and drainage.

2.0 EROSION: The storm event, what can happen.

It doesn't take much to start the erosion process. A heavy

thunderstorm quickly scours an unprotected roadway by forcing raindrops to impact the road surface. Frost action, water that has collected in depressions, and traffic have softened the surface, making it easily erodable. As a result, the rain washes out many of the fine soil particles that are a critical component of the road. Water begins to run down the sloping road in wheel ruts, removing even larger soil particles due to the concentration of the water plus its increased velocity.

The muddy water finds a path to the edge of the road and enters a ditch that has no way to slow it down. The water dislodges clumps of soil from the bare slopes and the bottom of the ditch and carries them off down the fast moving channel, breaking them up and dissolving the smaller particles as it goes. The water reaches a culvert that has heaved up due to frost action, allowing some of the water to flow under and beside it, loosening up more soil. The water that does make it through the culvert drops into a silty pool that has gotten deeper with past storms.

Finally, the water leaves the pool in a torrent, cutting a new and unfamiliar path through unprotected soil. This path finds its way to a stream that enters a lake carrying a brown plume of sediments and nutrients.

2.1 HOW EROSION OCCURS

In order to prevent erosion, or to control it effectively when it does occur, it is important to understand the sequential processes involved: rain drop impact, sheet flow, rill/gully formation and stream flow. Because the problems caused by erosion increase sequentially, it is vital to control erosion at its initial stages.

1. **RAINDROP** erosion occurs when rain impacts exposed soil particles, thereby dislodging and splashing them into the air. The dislodged particles can become suspended in the water and easily be transported great distances by surface water runoff.
Figure 2
2. **SHEET** erosion occurs when the action of raindrop splashing and surface runoff removes a layer of exposed surface soil. The water moves as broad sheets over the land and is not confined to small depressions.
3. **RILL AND GULLY** erosion occurs as surface runoff concentrates in rivulets, cutting several inches deep into the soil surface. These grooves are called rills, and in unrepaired rills or in other areas where a concentrated flow of water moves over the soil, deeper gullies develop.

2.2 FACTORS LINKED TO EROSION

Erosion by rainfall and runoff is related closely to a soil's ability to allow water to pass through the ground surface and to how well the soil particles stick to each other. Properties that affect a soil's ability to erode include: structure, texture, percent of organic matter, and permeability (ability of water to pass). Soils containing high proportions of silt and very fine sand are most erodible. The erodibility of these soils is decreased somewhat as the percentage of clay or organic matter increases. Clay acts as a binder between soil particles and organic matter, maintaining a favorable structure and improving

stability. The least erodible soils are well-drained and well-graded gravels or gravel/sand mixtures with little or no silt.

VEGETATIVE COVER shields the soil surface from the impact of falling rain and slows the velocity of runoff by creating a natural filter or buffer. Plants aid in aerating and removing water from the soil, thus maintaining the capacity of soils to absorb water. Plant root systems help hold soil particles in place.

TOPOGRAPHY AND CLIMATE also affect erosion. The size and shape of a watershed affects the amount and rate of runoff. Slope length and steepness determine water volume and velocity. The direction of a slope may affect the vegetative cover. For example, south facing slopes tend to be dry and have less vegetation, hence less erosion protection.

The frequency, intensity and duration of rainfall have an effect on soil loss. As both the volume and velocity of runoff increase, the capacity of runoff to detach and transport soil increases. The seasonal fluctuation of temperatures tends to loosen soil. Finally, melting snow can add greatly to runoff and cause excessive Springtime erosion.

2.3 ROADS AND EROSION

It has been estimated that up to 85% of all erosion and sedimentation problems in lake watersheds originate from the construction and improper maintenance of dirt or gravel surfaced roads that we call *camp roads* for convenience in this manual. One study shows greater phosphate pollution from this sediment than from nearby septic systems. While the true figures may be less, camp roads are one of the biggest environmental problems we face today in urban and rural lake watersheds.

Camp Roads:

- Remove vegetative cover from the watershed.
- Change topography and natural drainage patterns in the watershed.
- Change seasonal temperature fluctuations of surrounding area.
- Introduce highly erodible soil materials into the watershed.

Besides the long-term environmental problems caused by erosion, there are many other problems that create hardship for camp road users. Ruts, bumps and potholes can destroy a car's suspension, mud or washouts can make a road difficult or impossible to drive on, and dust pests not only following motorists but adjacent landowners as well. This manual addresses each of these problems because it is impossible to discuss erosion control problems with private road owners until they have achieved at least a moderately successful road surface maintenance program.

First, however, it is important to understand the source of almost all problems related to road... **water**.

3.0 WATER: ABOVE AND BELOW GROUND

The two things that combine to cause problems with camp roads are *water* and *traffic*. Usually we cannot limit the amount of traffic, so our

effort must be to control the effects of water, both above and below the surface.

3.1 SURFACE WATER is flowing or standing on top of the earth's surface. With respect to roadway maintenance, we are concerned with getting rainwater off the road surface as quickly as possible and directing it to a natural or man-made drainage channel capable of handling the flow without eroding.

The following measures help to drain water from the road surface:

- A road cross-section that is properly crowned and graded.
- Ditches sufficient to handle the necessary volume of water without eroding.
- Culverts that are properly sized and installed.
- Turnouts and buffers that return surface water to natural courses.

3.2 SUBSURFACE WATER OR GROUNDWATER is *below* the earth's surface, at a level known as the *water table*. With respect to roadway maintenance, we are concerned with keeping this water out of our road. Water in the road base makes it unstable, susceptible to rutting, and potentially impassable. If necessary, we need to drain subsurface water from the road base and direct it to a natural or constructed watercourse capable of handling the flow without eroding.

Methods of draining groundwater from the road base or lowering the ground water table include:

- Subsurface drains — either pervious pipe or permeable soil material.
- Open ditches, the same ditches used to handle surface water

Before beginning a discussion of how to deal with water on roads, however, it is essential to understand some basic information about the materials that are used to build them.

4.0 SOIL: THE MATERIAL USED TO BUILD CAMP ROADS

Soil exists everywhere on the surface of the earth except where it has worn away to expose bedrock. Most soil is made up of pieces of rock that has weathered due to the action of the elements over time. Soils can be made up of many different size particles, from large rocks to particles of sand to specks of dust that are too small to see. Materials used to build roads should consist of a carefully selected mix of several of these.

4.1 SOIL CHARACTERISTICS

Characteristics to consider when examining the materials used for roads, called *aggregates*, are: size, shape, durability, and permeability. Each helps determine if a material is suitable for use in some part of a road structure.

SIZE: Larger soil materials can range from boulders (used for culvert headers and erosion control) to small stones which make up the *gravel* used in the base of a road. *Sand* consists of smaller particles that can vary from as coarse as rice to as tiny as the eye can see. *Silt* particles

are smaller than can be seen with the naked eye. *Clay* is so fine that a moist lump of it feels greasy to the touch.

For this handbook we will consider the classifications of soil as shown in the following table.

Soil Type	Particle Size (mm)
Gravel	greater than 2.00
Sand	between 2.00 and 0.074
Silt	between 0.074 and 0.002
Clay	smaller than 0.002

SHAPE: The stones that make up gravel can range from being very *round* to being very *angular*. This factor is most important when considering the type of material to use for the surface of a road. Rounded stones have a tendency to roll out of the roadbed, especially on hills and curves, while angular stones have the ability to lock together for stability. The more angular a material is, the more suitable it is for road surfacing.

DURABILITY: As with shape, this factor is particularly important for surfacing material. Different areas of the country and even different soils within the same area can have different types of rock with varying hardness and, therefore, greater or lesser resistance to wear.

PERMEABILITY: This defines the soil's ability to allow water to pass through it. The more permeable, or porous that a soil is, the faster water will drain. Clean sand and gravel usually let water pass freely while soil that contains more silt and clay drain slower.

4.2 WHERE ROAD MATERIALS COME FROM

Most road building materials are taken from a gravel or "borrow" pit. Without processing of any kind, such material can contain rocks of any size. There are two ways that this *bank run gravel* can be processed to limit the size rocks and stones in the final product. Screening the gravel removes all rocks and debris that are larger than the holes in the screen. Processing bank run gravel in a stone crusher breaks down the large rocks to a uniform maximum size resulting in *crushed gravel* that is also known as *crusher run*. This crushing process is also done to blasted ledge or bedrock, breaking large pieces of rock down into small pieces and also creating stone dust that is actually particles of sand, silt and clay. Screened and crushed gravel also have stones in it that are no larger than the designated size (such as 1½" 1" or ¾") but also contain all of the smaller sands, silts and clays.

Screened gravel often has many stones that are rounded due to the way the gravel was formed by nature. Crushing bank run gravel helps to produce more angular material, as all stones that are larger than the designated size are broken down by the crushing process. Crushing ledge results in a product that is the most valuable surfacing material because every bit of it is broken and angular. The durability of the final product depends on the strength of the original rock that produced the gravel.

Gravel's permeability can be a result of many factors. Well-built roads

use materials of different size aggregates and permeability for different parts of their structure.

5.0 GOOD ROADS START AT THE BOTTOM

It often helps to understand the structure of a road by comparing it to a house. Just like a house, a road needs a foundation that provides support for everything that rests on top of it. A road base must be able to drain well or at least withstand the effects of groundwater through all circumstances or it will cause the structure above it to fail. Both house and road must contain durable materials throughout. Finally, they both require something on top that can withstand the elements and shed water to keep the structure below it dry.

5.1 THE BASE OR SUBGRADE:

There is not space here for a complete discussion of proper road building techniques, and most of those using this manual are faced with maintaining a road that has already been built. However, it is essential to be able to recognize when a particular problem with a road is caused by inadequate base materials and/or by poor drainage. Patching over existing road base problem is like painting over rotten wood. Note the number of *paved* roads that crumble each spring because they were never properly built from the bottom up.

5.1.1 MATERIALS

Just as when building a house, the foundation for a road must be carefully constructed first. All stumps, large rocks, and areas of soft or organic soil must be removed and replaced with well drained, coarse gravel containing less than 10% fines (silt and clay). Bank run gravel with the large rocks removed can work well. Gravel that has been crushed to a maximum size of 6" is more expensive but generally provides an excellent base. Good gravel also has excellent weight bearing capacity and is very stable when used in a road structure.

However, even a road base that is made from well-drained material can perform poorly if too much groundwater is allowed into it. Just like a house, there must be some means to keep water out of the road structure.

5.1.2 DRAINAGE

Surface ditches serve a number of purposes in any road situation. Note that the shape of the road in figure 3 provides for ditches on each side. When properly constructed and maintained they will:

- Drain subsurface water from the base and subgrade, improving the structural qualities of the road.
- Collect surface runoff and channel it away or to a proper crossing point in the road.
- Serve as a storage area for large amounts of rainfall.
- Collect and retain soil particles that normally would be washed into a channel way.

Ditches should be kept clean to allow water to flow freely from the roadway. From there, water should be routed away from the road rather than allowed to settle alongside into depressions where it will

cause the road to weaken. Ditches also must drain water away from property that it might damage.

Note that it is good practice to discuss changes in drainage patterns with the landowners that receive runoff waters to protect their rights as property owners.

Further information on ditching is presented in **section 8.0**.

Limited rights of way, stone walls, and other restrictive problems with existing camp roads often make it impossible or impractical to achieve a proper road cross-section with adequate side ditches. In this case it may be necessary to draw the water out of the road base by another means.

Subsurface drains provide a means to intercept ground water where it is not possible to provide adequate side ditches. Pervious (perforated or slotted) pipe is bedded in porous sand or gravel in a ditch along the edge of a road and run downhill to a safe outlet. The pipe draws in groundwater, removing it from adjacent areas and preventing it from reaching the roadbed. The deeper the pipe is installed, the more effect it can have on draining a road. The limiting factors in this type of installation are the need for slope to move water by gravity, and the need for a place to safely outlet the water.

Removing water from under a road is very much the same as installing perimeter drains around a house.

5.1.3 GEOTEXTILES: a new alternative for old problems

An exception to some of the above rules has developed in recent years with the advent of burlap-like synthetic fabrics that are being used to solve unstable road base problems. Geotextiles have made it possible to cost-effectively stabilize roads without having to dig up and replace *any* base material *or* provide additional drainage.

These special fabrics are simply rolled out over an unstable section of road and covered with several inches of gravel. The fabric comes in long rolls that are 12.5', 15' and wider. It is inexpensive, readily available, and easy to use. For years it has been simplifying new road construction and solving past problems quickly, easily, and, as far as experience has shown, permanently.

Repairing road base with Geotextiles

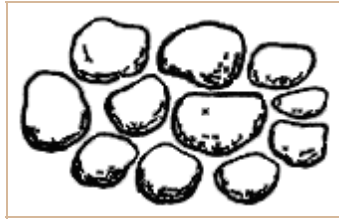
5.2 THE SURFACE

The surface of an unpaved road must, like the roof of the house, be able to shed water to protect the rest of the road below it. It also must be both strong and firm enough to withstand the wear and tear of vehicles driving over it.

Wearability: Surface gravel should always contain a considerable amount of stone that is resistant to wear. Also, the more *angular* the stone is, the better, because it is angularity that helps keep stones locked together in the road surface in spite of the action of wheels tearing at it. This is why crushed gravel, and particularly crushed ledge is preferable to screened material.



angular (good)



rounded (poor)

Size: The maximum size stone recommended for a finish surface is 1" or less. Larger stones, especially if they are rounded, have the tendency to become dislodged from the surface on hills or curves. In our area of New Hampshire, $\frac{3}{4}$ " crushed gravel is the most commonly available surfacing material, and $\frac{3}{4}$ " crushed ledge, which is often blue in color, is used on more formal roads and driveways.

Cohesion: Road surfacing gravel needs to be able to hold itself together to fight the effects of water and traffic. It requires *binder*, in the form of particles of silt and clay to fill the voids between the larger aggregates and act as a sort of cement. Surface gravel should not allow water to pass through it into the base. Instead, it should shed water to the ditches because of its shape.

Unfortunately, much of the crushed gravel manufactured by large sand and gravel companies is designed to be used as a base layer under asphalt pavement. It needs to be able to bind together only enough to support the paving machine that lays down the permanent surface. In this case it is preferable that the gravel drain so that it does not retain water under the pavement.

"The dirtier the better."

Surfacing gravel, on the other hand, needs *lots* of binder to keep it together. Therefore it is necessary to keep any fines that may have been a part of the gravel originally or are the product of a crushing operation, rather than screening or washing them out during manufacture.

The ideal mix for surface gravel should contain almost 50% sharp angular stone of a maximum size of $\frac{3}{4}$ " with enough sand, silt and clay to fill up all of the spaces between it and lock it together. When wet it can have almost the consistency of wet cement, to the point of being muddy, and when dry will set up almost as hard to the touch.

Determining the mix:

How do you find out just what percentages of these different materials you have in your existing road or in the gravel someone is trying to sell you? It is easy to estimate the amount of stone and its shape by visual inspection, but figuring how much sand, silt and clay particles are present is quite difficult, especially because the smaller particles are invisible.

Engineers perform this test with a set of precision sieves (fine screens). The percentage and size of soil particles is determined by the size of the sieve mesh opening that the particles are retained on after sifting. As most of us do not have access to these sieves, a simpler test is quite helpful.

The Veryfine test

Find a clear container such as an empty juice bottle (glass or plastic) with a fairly wide opening. Fill it half full with the soil material to be tested. Add water to fill the container then shake well. Set the container down and notice that the largest particles settle out immediately while the smallest particles remain in suspension for a long while, the same as they do during the erosion process. After sitting long enough, the water becomes clear again. The different materials in the sample have graded themselves and allow you to see the approximate percentage of each soil type in the sample.

A simple field test for fines is to grab a small fistful of the gravel to be tested and wet it with a little water. If the whole mass becomes muddy and smears against your skin as you work it around in your hand it contains fines. If its consistency does not change and it fails to become pliable or smear your hand, it does not contain fines. Also remember to look for the size, shape and percentage of stone. Without adequate stone a road surface will not be stable and stand up to wear.

The desired amount of fines in the different parts of a road are listed in the following table. These gradations will allow for proper drainage over and throughout your road cross section.

Road Layer	Percent Fines
Surface	7 to 12% fines
Base	5 to 10% fines
Subgrade	0 to 5% fines
Seeding Material	5 to 10% fines

5.3 ROADS BUILT INTO NATIVE SOIL

Properly constructed roads are built above the natural ground. Many camp roads, however, were originally built simply by removing the organic layer and cutting into the existing soil. Often there has been little or no gravel added either to reinforce the base or to form a surface. Although not ideal, these "native soil" roads can be satisfactorily where local soils are reasonably strong and well drained. Where native soils are not adequate, it is necessary to provide some other means of support or drainage, such as the addition of surface gravel over geotextile.

Often the right-of-way for a camp road is too narrow or the road is cut too deep into the parent soil to allow for the construction of an ideal road cross section that includes proper side ditches. In this case, more than ever, it is necessary to maintain a proper shape on the surface of the road to minimize the chance of a significant rainstorm causing severe damage due to limited ditch capacity.

6.0 GRADING THE SURFACE FOR PROPER DRAINAGE

while also getting rid of those Ruts, Bumps and Potholes

The amount and type of use a road receives determines the type and frequency of grading necessary. For example, trucks carrying heavy loads flatten the crown and create wheel ruts where water can collect and travel. Cars traveling too fast blow away light soil particles from the road surface and cause washboarding. Heavy summer rains cause washouts. Steady light rain with lots of traffic on an improperly

crowned road results in potholes. And snowplows often dig up roads if it snows before they freeze, and particularly, after they begin to thaw in the spring.

The condition of the road surface determines whether a road should be smoothed or reshaped.

6.1 RESHAPING is generally done late in the spring of the year when the road is still soft but not unstable. Reshaping involves *cutting as deep as necessary to get to the bottom of all ruts and potholes*. In many cases there will be a berm (ridge of gravel or dirt) at the edge of the road that results from snowplows pushing aside unfrozen gravel, accumulated winter traction sand, and the scuffing action of wheels, especially on curves. This material must be reclaimed by pulling it to the center of the road. All of the loosened material is now blended and reworked as if it were new and properly shaped into a crown.

6.2 SMOOTHING is the process of regular maintenance and involves less penetration into the road surface. It should be done as often as necessary to keep the road from needing to require reshaping.

6.3 WHEN TO DO IT The best time to smooth or reshape a road is immediately after a rain. Water helps to loosen the surface, reduces dust during the process, and yet also helps allow the material to recompact after grading. Never work a dry road, especially if it does contain a large amount of fines.

Neither the reshaping nor smoothing process should ever allow the formation of a berm or ridge beyond the work area at the edge of the road above the ditch. Even the tiniest "false berm" acts as a barrier to surface water drainage, particularly on hills, and prevents water from properly reaching the ditch. It could be the cause of very serious damage in the future.

6.4 THE CORRECT SHAPE OR "CROWN" A gravel road surface that is too flat permits water to puddle in low areas where it softens the surface, weakening the roadbed by encouraging water to seep into it and also loosening up the surface fines. As traffic splashes water out of the puddles, the fines are carried away and *potholes* begin to form.

Roads should be crowned, or pitched, to promote drainage of surface water from the road into roadside ditches to minimize the detrimental effects of water. Figure 5 depicts how crowning promotes proper drainage.

On those narrow, sunken, "native soil" roads that are built down into the ground, the crown still sheds water to the sides of the road. There, however, it is forced to run in the low point between the traveled way and the upsloping shoulder of original soil rather than down into a constructed ditch line. Again this is not ideal, but very common in camp road construction. In every case, however, the rules for proper crowning still apply.



Figure 5: shows proper "A" shaped crown, typical parabolic or

rounded crown, w"shape of many camp roads, and depressed "native soil" road

A rule of thumb for gravel roads is 1/2 to 3/4 inches of pitch per foot of width. The steeper the road the more pitch is desired. Roads with greater than 3/4 inches per foot are difficult to maintain and drive over, however.

This pitch should continue over the *entire road width* from one shoulder to the other. Curved road sections often maintain this single pitch across the whole road by sloping only toward the inside of the curve. Most roads, however, break the pitch in the middle, resulting in the "A" shaped or "teepee" *crown* shown in the figure 5. and *not* the rounded crown that is so common. The problem with a rounded crown is that it allows the formation of potholes in the middle of the road where the surface is the flattest and wheels going *both* directions tend to drive.

See article: **Getting your Crown in Shape**

Note that single lane roads and driveways do not require the "A" shaped crown because vehicle wheels seldom touch the center of the road. Although it is still critical to provide a crown, it is acceptable for it to be rounded in the center.

Measuring the crown

A crown of 1/2 inch per foot means that a 20' wide roadbed (two 10' lanes) should have a centerline five inches higher than the edge of the road. That represents 1/2" of rise for each foot of width from the center to the edge. The simplest tool for checking this crown is a straight piece of wood or metal ten feet long with a carpenter's level on top. One end of this "gauge" is set in the middle of the road and the other end propped up on a rock or the toe of your boot until it is level. The distance from the end of the gauge to the ground should be five inches.

[By contrast, paved roads generally require only half this pitch, or 1/4" per foot or 2 1/2" for a 10' lane. Other paved surfaces like driveways and parking lots require even less pitch to shed water, about one inch per ten feet. The integrity of the paving material is generally adequate to keep potholes from forming, even if there is an occasional "birdbath".]

Reshaping, smoothing and restoring crown each require cutting into the road surface and redistributing the gravel. Also, because reclaimed material often contains significant amounts of debris it is important to be able to separate it and maximize the amount of material reclaimed. We examine those considerations in the section: **How to Do It.**

6.5 OTHER ROAD SURFACE PROBLEMS Proper road surface maintenance will get rid of ruts, bumps and potholes by cutting them out and restoring crown. *Maintaining* that crown is the best defense against having these problems return. There are other problems, however, also caused by traffic and water, that require different solutions.

Slick or muddy surfaces generally result from too many fines and not enough stone aggregate.

Washboard is usually caused by too little fines to hold the road

together coupled with high travel speeds (and worn out shock absorbers on the vehicles using the road.)

Aggregate separation, stones separating from the road surface gravel, result from not enough binder in the surface along with too much rounded stone, especially if it is too large.

Dust is the result of fast traffic over a dry road surface with too much binder and, sometimes, with *too little*. The faster the traffic moves and the drier the surface, the more dust will be created. Dust carried off of a road surface means a depletion of the fines that are supposed to hold it together, creating a maintenance problem over and above the nuisance factor for motorists and adjacent landowners. Dust can be reduced with the addition of calcium chloride, a chemical that can also help to stabilize the road.

There must always be a proper balance of stone, sand, fines and moisture in a properly crowned surface for good stability. When any one of these is missing or present in the wrong proportions, problems will occur. For a closer look at each of these conditions and recommendations for their cure, see the accompanying **Road Surface Troubleshooting Guide**

7.0 HOW TO DO IT Why shouldn't it be a drag?

A traditional way to smooth a camp road was to drag a long steel "I" beam or an old bedspring or piece of chain link fence weighted with a log behind a tractor or pickup truck. While a drag of this type does help to redistribute material, it does little to cut to the bottom of potholes, reclaim material from the shoulder, separate accumulated debris, or restore crown. In fact, indiscriminate use of a drag can often help to destroy a road by removing a crown and digging out the center of the road. Drags are also difficult to turn around in a dead end road or driveway.

This section examines the proven methods of road surface maintenance and some of the different types of machines used to perform them.

7.1 THE METHODS

As mentioned, regrading a road usually involves cutting into the road surface and scraping the edge into the center to remove the false berm, reclaim material, and reconstruct the crown. Debris must then be separated from reclaimed material and pushed into piles and loaded out or pushed off the side of the road to a place where it will not obstruct the flow of water or infringe on the right of any adjacent landowner. It must also be kept out of delicate wetland areas. Debris can range from rocks and vegetation to discarded rubbish and occasional car parts that have fallen off cars bouncing over potholes.

Where there is little or no surface gravel to work with, regrading can loosen up road base material. Where there is no base gravel, such as in native soil roads, it can dig into the original soil. Either of these materials is likely to contain many stones of varying size. It is possible to reuse much of this stony material by working it into the very center of the road where the new crown will be built up the most. In this way, only the largest stones will have to be separated out with other debris.

When a road is sunken like the native soil roads already discussed, the entire width of the road must be graded, taking special care to remove collected leaves and debris from the edge of the road. Failure to remove this debris can force water out onto the traveled way where it is likely to erode a new path around it. The fact that this road configuration simplifies debris cleanup by allowing it to be easily done with certain types of equipment while regrading is its only advantage.

7.2 THE MACHINES

Machines used for camp and development road maintenance range from road graders built specifically for the purpose to trucks and tractors fitted with various attachments. While each device has different features and benefits and must fit individual circumstances, it should also meet the following criteria to be considered suitable.

A device used to adequately restore and maintain a road must be able to:

- cut into the road surface to remove potholes and washboard.
- reclaim material from the shoulder and move it to the center to restore crown
- separate rocks and debris from reclaimed material
- spread new material when necessary
- mix materials into existing surfaces for repairs, and
- provide a means of control to establish a finish grade

In addition to these traditional functions, is also helpful when the same device that can:

- dry out soft and muddy roads in the springtime
- remove snow from unfrozen road surfaces (to reduce snowplow damage)
- cleanout and reshape water turn outs, swales, and rolling dips (to be examined later)
- be easily transported for efficiency of operation
- take advantage of existing power equipment when possible, and
- be easy and comfortable to operate.

Choosing the best system: advantages and disadvantages

The ideal machine for maintaining unpaved surfaces is the road grader. This sophisticated tool is unique in the way it can reposition its blade for a variety of operations. In the right hands it will cut out potholes, reclaim material, restore crown, clean and shape side ditches and do almost everything necessary to maintain a road.

Narrow, winding, and rolling camp roads often present a problem for these machines, however. Graders are usually quite large and expensive and require a skilled operator for good results. Therefore, many other devices have become popular for this purpose, some of which are effective and some little better than the bedspring drag.

While there is a wide range of equipment used for road maintenance,

the actual part of the tool that meets the road falls into one of two categories: a rigid **blade** or a spring tooth **rake**. The tool can be an integral part of the operating vehicle (such as the blade of a bulldozer), or a separate device attached to a multi-purpose vehicle. Either type can be mounted in front of or behind the operator, depending on the carrying vehicle.

Rigid blades are the working part of roadgraders and bulldozers, and are used as attachment on the back of agricultural tractors. The advantage of the rigid blade is that it can usually be positioned at an angle that lets it cut out potholes, pull in shoulders, restore crown and also clean side ditches. The disadvantages of a blade are that it requires slow operating speeds because of its rigid attachment to the carrier and also that it has trouble separating out debris.

A "box scraper" that fits behind a tractor is a type of rear blade that is fitted with sides making it somewhat similar to the front bucket on a tractor-loader. While either one can cut into surfaces effectively, they cannot easily separate debris or reshape and restore crown.

Flexible tine rakes use spring steel tines in place of a blade. They are often mounted on the back of farm or industrial tractors, while tow-behind rakes are self-contained units designed to be pulled behind trucks or tractors. The advantage that tines have over a blade is that they provide shock load protection to the carrying vehicle, allowing higher operating speeds, and they excel at separating debris. With proper positioning, they can cut potholes and washboard, reclaim material, restore crown, and finish grade. Disadvantages of flexible tines are that they can sometimes individually bend or break when hitting obstructions and are generally more costly than rigid blades to purchase and replace. This cost, however, has to be balanced against their overall efficiency and the protection they afford to the operating vehicle.

Many rakes were designed primarily to complement a road grader for removing rocks and debris after blading. Some models are too wide to work each lane of a camp road individually, and unskilled operators are inclined to remove the crown of the road along with debris during raking.

Front or back mounted: Where a tool is mounted, along with how easily it is controlled, dictates whether it is suitable for actual grading or strictly for smoothing. The blade of a road grader or bulldozer is in *front* of the operator where he can see both the tool and the work being done. Rear mounted tools are much more difficult for an operator to control, particularly when having to continually compensate for changing topography and conditions. In addition, front mounted grading tools usually penetrate a road surface more readily than rear mounted tools because the operating vehicle pushes them into the road surface rather than pulling them out.

Recently, a heavy-duty attachment with stronger and more aggressive tines has been introduced as a front mounted alternative. It has been adapted to the snowplow hoist of pickup trucks, taking advantage of the existing hydraulic lifting and angling controls for its operation. It also mounts in place of the bucket on the front of a tractor where it offers greater visibility and control, providing much the same operating configuration as a road grader. According to a recent USDA Forest Service report, the "Front Mounted Rock Rake" as they call it "is 70%

less costly to operate than a road grader" and, because it fits on a multi-use, high mobility vehicle is readily "available when needed."

Availability is critical, regardless of the type of equipment used, because it is regular maintenance performed *before* a road surface becomes badly worn, rutted or washed out that helps to reduce long term cost while also reducing erosion and sedimentation. Observing the efficiency of a front mounted grader/rake at work in a Maine State Park a few years ago a ranger quipped that the key to maintaining a road with this piece of equipment is to **"go fast and go often!"**

7.3 COMPACTING AFTER GRADING

Once a road is regraded, the surface must be recompact to help consolidate it. This can usually be accomplished adequately by the wheels of regular vehicle traffic. In fact, wheeled vehicles are generally preferred for compaction because they concentrate the entire vehicle weight on a very small area showing up any imperfections immediately and allowing them to be reworked before they redevelop into potholes. Steel rollers, on the other hand, have the tendency to bridge such imperfections. A loaded dump truck is ideal for final compaction so long as the road base is firm enough to support repeated passes with a heavy vehicle.

Now that we've examined the construction and maintenance of the road itself, it is necessary to consider the next step in proper drainage — where the water will go after it leaves the road.

8.0 GETTING WATER SAFELY AWAY FROM THE ROAD

As water runs off the surface of a road it becomes concentrated, creating a potential for *washouts*. As more water collects and begins to move faster, it increases this potential because erosion is a function of

Volume and Velocity!

A large amount of water travelling slowly often has less effect on the ground surface than a small amount of water travelling very fast. A garden hose directed onto one spot of exposed ground creates a gully very quickly. A large volume of water travelling rapidly over the same unprotected soil can have devastating effects. Therefore, proper design of a drainage system must seek to reduce the concentration of flow whenever possible.

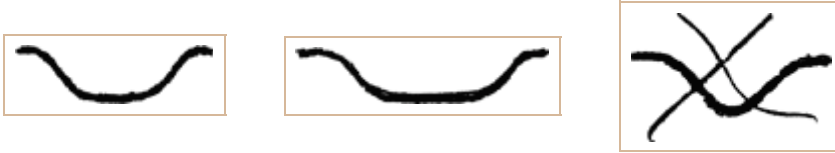
8.1 DITCHES, as already shown, are essential for proper drainage. Although they should be installed during initial construction they can be added later. Ditches should be installed or reshaped *only* when there will be enough time and moisture for vegetative growth to take hold unless other specific measures are taken to prevent soil loss. Erosion can damage the road itself and deposit unwanted material in any water channel or structure downstream from the eroding site.

Road ditches should be designed to handle total volume and velocity of water for the particular road location.

Size: The width and depth of a ditch should be based on runoff volume and on the drainage needed for the road base. This includes the groundwater drainage needed to lower the water table in the road base to make the road firmer and stronger, if necessary. As a rule of

thumb, the water in a ditch should never come closer than 1 foot from the edge of the road. This will also allow for ice buildup in the winter and an occasional hurricane or other major rainstorm.

Shape: Parabolic or flat bottom ditches spread runoff water over a larger area than V-shaped ditches, helping to reduce erosion



Parabolic ditch Flat bottomed ditch V shaped ditch
Figure 9

Stabilization: Ditches must have some means to protect the soil from washing such as vegetation or rock lining.

Ditches that lack such protection, or are too small or incorrectly shaped, will continue to erode until one or a combination of two things occurs:

- All erodible material is washed away, usually leaving large stones behind, and/or,
- The channel widens until the velocity slows to a point where erosion stops.

Ditch erosion can be reduced a number of ways:

- Widen the channel. The wider and flatter the channel is, the more volume it can handle at a slower velocity.
- Provide for a stable ditch bottom by armoring it with rocks or other material. Installing rock lining comparable in size to that left by the stormwater is a good design rule of thumb.

Side slopes are that part of the road most prone to erosion as they have the steepest slope and are made of materials that erodes most easily. They should not be so steep that it is difficult to establish vegetation or hold stone on them.

Inspecting a road ditch during a heavy rainstorm can help determine whether it is properly constructed and sized to handle stormwater runoff. The presence of muddy/silty water, and/or water overtopping the banks of the ditch are generally indicative of an improperly sized ditch.

See Proper Ditch Design for more comprehensive information regarding ditch sizing and design or contact your local Natural Resources Conservation District or other qualified individuals for help.

In many situations it may not be possible or desirable to continue a drainage ditch along one side of a road because:

- changes in grade or side hill contours force water to drain toward the other side of the road,
- obstructions such as boulders, ledge, driveways or other roads block the flow of water,
- adjacent areas are prohibited from receiving runoff because they

are environmentally sensitive or protected by landowner's rights.

In each of these cases it is necessary to provide a means to allow water to cross the road without causing erosion or danger to vehicle traffic. As it is usually the most complex and expensive portion of any road, cross drainage is often the most overlooked.

8.2 CROSS DRAINAGE utilizes various structures to channel water either under or over the road surface in a controlled manner. The volume and seasonality of traffic and the type flow to be contained control which type of structure should be used.

BRIDGES allow a road to cross over rivers or streams where there are extreme flows of water. They require careful planning and construction. Bridges can be built in place or prefabricated of wood, metal or concrete. In recent years, large round or oval prefabricated metal or concrete pipes are often used in place of traditional bridge structures.

CULVERTS are generally considered to be commercially available round pipes made of metal, concrete or plastic. They are usually used where:

- There is a need to allow an intersecting stream or brook of moderate size, or a seasonal runoff to continue to flow as it did before the road was built.
- Water flow in the side ditch becomes too much for the ditch to handle but cannot be drained away on the same side of the road.
- Boulders, ledge, changes in grade, or road intersections interrupt the flow in the ditch, or
- *Adjacent property is protected from receiving storm water by individual owner's rights or because of environmental sensitivity.*

SWALES, STONE FORDS, OR BROAD-BASED ROLLING DIPS are stabilized depressions in the road surface that channel water across the road. They can be used in place of a culvert

- to handle moderate seasonal flows, especially where or when there is minimal traffic,
- to drain stormwater, or
- to act as an emergency spillway over a road in conjunction with a culvert that may not be large enough to handle large flows.

WATER BARS: are closely related to swales or rolling dips but are a much more abrupt rather than gradual. They are often used on steep grades where traffic is minimal and travels slowly, and the road is not plowed during the winter.

It is reasonably obvious where bridges or large diameter culverts must be used. Choosing where to use a culvert versus a broad based dip or water bar involves an understanding of the advantages and disadvantages of each.

Choosing which cross drainage structure to use

CULVERTS: Properly installed culverts are unnoticeable to the traffic passing over them, which is why they are the method of choice for most cross drains. Improperly sized, installed, or maintained, culverts

can quickly become a liability, however.

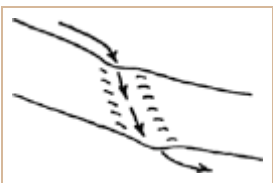
- **SIZING:** Culverts must be large enough to handle maximum anticipated flow or they can result in the loss of the road when excess water washes over it in a heavy rain. Culverts must also be large enough to permit proper maintenance and long enough to completely reach from the bottom of the road slope on one side to the bottom of the slope on the other.
- **INSTALLATION:** must follow several guidelines to prevent sagging, collapse, or water leakage alongside that can result in washout. Adequate headers at the inlet and outlet of the pipe must be provided to protect the culvert and support surrounding soil.
- **MAINTENANCE:** Culverts need to be kept clear of debris that can accumulate at the inlet, and from rocks and sediment that collect in the pipe. They need to be kept clear of ice during particularly cold and wet winters to keep from plugging. As some culvert materials deteriorate over time, culverts can require periodic replacement.
- **PERMITTING:** Most states and some communities require permits for the installation and replacement of all culverts, not just those for regularly flowing streams, but even those designed to handle only occasional storm flows.

FROST ACTION: Not only can culverts freeze up, plug up, rust out or wash out, they also are subject to the action of frost. Because cold usually settles into an open culvert sooner than it goes into the surrounding soil (remember, bridges freeze first!), many culverts in frost active soils heave up into the road as winter progresses. Over the years, this action can lift a buried culvert right up out of the roadbed and leave a cavity beneath that allows stormwater to flow under rather than through it, eventually washing it out.

Conversely, culverts that contain constantly flowing water have the tendency to lag behind as the rest of the road pushes up due to frost action. The heat of the flowing water keeps the culvert from lifting with the rest of the road and creates a sharp depression across the road surface.

In spite of all this, culverts remain the most suitable way to get water across a road in most situations. Improvements in lower-cost culvert materials in recent years such as the new smooth-wall plastic pipe have helped address some of these problems.

There are low-cost alternatives to standard culverts that can be used on low volume roads such as wooden box or open top culverts. For further description of these and also a more complete guide to culvert sizing, materials, permitting, installation and maintenance see **CULVERTS**.



Rolling dip

BROAD-BASED ROLLING DIPS consist of a wide swale across the road. While these may be a disadvantage to some who have to drive over them, they may well be an advantage to others who view them as speed bumps or thank-you-ma'ams to slow traffic. These depressions in the road need not be exceptionally deep to achieve their purpose, however. In fact, the wider and shallower they are, the more effective they become at allowing larger volumes of water to cross while reducing its concentration at the bottom.

Rolling dips can be constructed when a road is built or anytime thereafter. For proper stabilization they simply require digging out a portion of the road and replacing the original material with crushed stone large and angular enough to lock together to hold in place as water flows over.

This stone is shaped to the final grade of the dip and then regular road surfacing gravel is spread over and worked into the stone to further lock it together to keep car wheels from spinning on the loose stone.

The completed broad-based rolling dip is indistinguishable from the rest of the road except for its shape. Unlike a culvert, it cannot plug up or freeze, needs no headers, and cannot heave, settle, collapse, or deteriorate. It is easily maintained when the road is graded by removing accumulated debris and lightly reshaping if necessary.

The flatter the road, the wider and easier it is to create a rolling dip. As roads become steeper, the dip has to become narrower and deeper to accomplish the same goal. If a road is kept open through the winter, there is danger of a snowplow doing damage to the lip of the dip, allowing water to flow down the road and rendering it useless.

WATER BARS: can be used as low-cost alternatives to culverts when roads become too steep for broad based dips to work and there is minimal slow speed traffic. A water bar is a shoulder or berm constructed across the road that intercepts water running down both the road and the ditch line and forces it across the road. Because of the steepness of the road where water bars are likely to be used, it is difficult to construct them using just soil as is done with a rolling dip. Passing vehicles will chew up and destroy the berm.

Temporary water bars are often constructed on logging or construction roads by placing a log across the road. More permanent water bars can be constructed of pressure treated lumber. Variations of the water bar include the open top box culvert that leaves the surface of the road flat except for a narrow channel, and rubber strips that stick slightly above the road surface to intercept water but let vehicle wheels pass easily.

The disadvantage of water bars is that they are difficult to maintain through the winter so are generally limited to seasonal road use.

Knowing which solution to use to get water safely across a road requires a thorough examination of each circumstance along with some experience at making judgement calls, as well as an understanding of the financial constraints governing the operation of the road system.

Once water has been drained from the surface of the road and channeled across the road where necessary, it must be directed safely away from the road. All drainage must outlet into areas that are

properly stabilized and legally and environmentally suited to receive extra runoff water.

Getting water away from the road

TURNOUTS AND SPREADERS In an ideal situation, water running off the surface of a road sheds directly into adjacent grassed or wooded areas where it can soak safely away. Where this cannot happen, flow is channeled into the ditches and the various types of cross drains that have just been examined. Oftentimes this channeled flow enters directly into a stream or pond. Although this would seem to be a natural way to return stormwater to the hydrologic cycle, this immediate short-circuiting from road and ditches usually results in suspended nutrients and sediments being carried into the waterways.

TURNOUTS: To avoid this, stormwater should be channeled away from the road onto grassy or wooded areas wherever possible. These channels, called water turnouts, allow the erosive energy of the water to be dispersed while also forcing suspended sediments to be trapped in the soil as the stormwater soaks into the ground.

Because it is always easier to handle and control smaller quantities of water than it is larger quantities, *turnouts should be constructed at every possible opportunity*. In this way, total volume and velocity are minimized, reducing demands on both ditches and cross drainage and spreading the stormwater over larger areas where it is easier for it to be absorbed.

Turnouts are an effective means of dealing with surface water and reducing the impact of camp roads on the overall environment. In effect, a turnout takes channelized ditch water that was collected from the road's surface flow and returns it to natural surface flow. Helping this surface flow soak away into the ground is accomplished by widening the turnout.

SPREADERS: are widenings at the end of a turnout that spread water over as large an area as possible to further reduce velocity and maximize absorption area.

Turnouts and spreaders can be constructed with almost any piece of equipment, keeping in mind that all of the same rules that apply to ditches for stabilization also apply to turnouts. In fact, most turnouts are simply a redirection of the road ditch off into the woods or fields.

Occasionally it is impossible or undesirable to turn runoff water out into adjacent land or send it across the road or to a stream. In order to get rid of the water, it must be sent directly into the ground.

SOAKAWAYS: are open holes in the ground adjacent to road ditches that provide a place for road runoff to collect and soak into the ground. They can be dug with a front end loader or backhoe and represent a very low cost way to handle stormwater. Occasionally they have to be cleaned of leaves, debris and sediment to return them to total effectiveness. These work best in porous soils.

DRY WELLS: are closed structures that also collect and store surface water and let it soak away into the ground. They are essentially closed top soakaways, usually built of concrete blocks surrounded with crushed stone. They usually have reinforced concrete covers with an open grate or a side opening for water to enter. Although they are the most expensive way to handle stormwater, they are occasionally

required as property development increases and landowner's rights begin to conflict with water management practices.

GRAVEL ROAD TROUBLESHOOTING GUIDE

This guide addresses many of the PROBLEMS that occur with camp roads, their CAUSES, APPROPRIATE SOLUTIONS and links to the text and further discussion. Although it is not possible to address every type of road situation here, I have attempted to address the major problem areas that face most rural camp and development roads. I hope this guide proves useful and I welcome any comments and feedback.

POTHOLES: depressions or holes in the road surface cause: road surface too flat combined with water and traffic

Solution: reshape or regrade to cut out the potholes and restore crown

Although potholes can also be caused by weak spots in the road base due to pockets of organic matter, rotting stumps or other base defects, the most common cause is lack of pitch causing water to puddle on the road. Restoring crown through regrading or smoothing the surface is generally required for repair. See **6.0 GRADING THE SURFACE**

DEEP MUD: that can be severe enough to close the road in the spring

Cause: poor base materials or drainage, or a combination of both

Solution: add stone, improve drainage or reinforce base with well-drained gravel or install geotextile

If a road turns to impassible mud in the spring, the only practical way to return it to service immediately is to add crushed stone (not gravel) to strengthen it. Stone is worked into the mud until the road is able to support passing loads. Though expensive, this scheme is very effective for emergency repairs.

See article: **BUCKET OF STONE PLUS A BUCKET OF MUD**

If the repair can wait for dry weather, drainage can be improved or the road base can be reinforced with strong, well-drained gravel. A lower cost solution is to install a geotextile layer over the existing road and cover it with 4 to 6 inches of surfacing gravel. See: **Geotextiles**

MUD HOLES: small areas of deep mud or quicksand-like gravel

Cause: Springs or pockets of organic matter under the road

Solution: Add stone or drain

Small pockets of mud or mudholes can usually be repaired with the addition of crushed stone in the same manner as deep muddy roads (ABOVE). If the source of the problem is an active spring, however, it is preferable to install a subsurface drain to remove the water from the roadbed.

Removing water from under a road is very much the same as installing perimeter drains around a house.

SURFACE MUD or slick surface. Road is firm but "greasy" on top:

Cause: Surface gravel lacks stone

Solution: Resurface with better gravel or add stone to existing surface

If the surface gravel is too thin it may be worthwhile to add gravel to a greasy surface to firm it up. If there is adequate depth of surface gravel but it lacks sufficient stone aggregate to provide strength, it can be cost effective to add crushed stone only and work it into the surface. Angular 3/4" stone is preferable for this purpose. See **5.2 THE ROAD SURFACE**

RUTS or SOFT ROAD: wheels sink in but do not break through, road remains passable

Cause: same as Deep Mud or Mud Holes above but less extreme, although with additional water or traffic can often become impassable.

Solution: Same as any of the solutions for mud above.

Road rutting can be only a minor problem or can signal the start of the breakup of a road. Heavier traffic or additional stormwater or melting snow can contribute to this breakup.

Experience and an understanding of the interaction of soil and water are essential to determining the true reason for roads becoming soft and muddy and are the essential first step in choosing a solution.

The above problems are the result of too much water in a road while the following are generally associated with too little water.

WASHBOARD: the series of evenly spaced bumps that make a vehicle chatter rather than bounce around like potholes

Cause: Road surface is tearing apart through the action of passing vehicles because the surface gravel lacks fines or adequate angular stone or moisture or a combination of the three.

Solution: Regrade the road surface to cut out the washboard and add good quality gravel with adequate sharp stone and fines. Treat with Calcium Chloride

Washboard is a direct function of traffic, especially fast moving traffic, usually on a dry road, regardless of whether it is upgrade or flat. Providing as hard and compact a surface as possible will help eliminate washboard. Good gravel with considerable fines helps to hold moisture. Calcium chloride increases the road's ability to retain moisture in dry seasons helping to consolidate it to help prevent washboard and other problems.

DUST is the result of surface fines being sucked out of the road by passing vehicles.

Cause: Too little moisture in the surface of the road and traffic moving too fast

Solution: Slow traffic through the use of speed bumps, add water to the surface, or treat with Calcium Chloride or one of the other surface stabilizers (*NOT OLD MOTOR OIL!*).

As dust lifts out of the road it not only creates a nuisance for motorists and adjacent landowners but also, as it blows away it, means a loss of the cement that helps hold the road together. This can amount to many tons of soil loss each year per mile of road. Dust also

contributes to nutrient pollution because after it settles on nearby foliage or other surfaces, it can be washed off by rain and carried into surface waters.

Calcium chloride (CaCl) attracts water and holds it in the surface of the road even when applied in moderate amounts. As mentioned under Washboard, CaCl also helps to consolidate a road surface, helping to prevent other defects. In more substantial applications it can actually help reduce total maintenance costs by reducing the necessity for grading. In many situations, the cost of calcium chloride treatment can easily offset the cost of soil loss and the environmental effects of having that soil enter surface water.

See: **Stabilizing Roads with Calcium Chloride**

AGGREGATE SEPARATION, particularly on corners and hills :

Cause: stone aggregate that is too large and/or rounded

Solution: rework stone into surface and topdress with good surface gravel. Stabilize with CaCl

Crushed gravel with stone that is larger than 1" has the tendency to have the stone "kick out" on hills and curves due to wheel action, especially when the surface is dry. These "rolling stones" can also help start a washboard effect.

Reclaiming loosened stone and working it back into the surface can help save it from being lost, but in more extreme conditions the only way to keep this loss from reoccurring is to cover this larger aggregate with a couple of inches of good 3/4" or similar gravel and recompact.

See **5.2 THE SURFACE**

LOOSE SURFACES: the "squirrely" road

Cause: Lack of fines

Solution: Cover with good surfacing gravel or mix in additional binder

While loose gravel on flat surfaces can create a headache, loose gravel on hills can be a detriment to travel, especially for light rearwheel drive vehicles such as empty pickup trucks or muscle cars. Sometimes even good gravel become loose when fines are lost to wind or to water such as the material that collects at the bottom of a washout. With care, fines can be added to this material and mixed in to reclaim it, or it can be left as base and covered with good surface gravel.

See **5.2 THE SURFACE**

WASHOUTS: rills or gullies where the soil has disappeared and been deposited downstream on the road, in the ditch, or into a waterway

Cause: too much water flowing in too narrow a channel over unstabilized soil

Solution: Slow the water down, spread it out, or stabilize the soil in its path.

Washouts that occur on road surfaces themselves are generally a result of inadequate grading that allows water to channelize rather than staying spread over the whole surface. To avoid this, roads

should be properly crowned, road shoulder false berms should be removed or never allowed to form, and cross drainage should be kept free and clear of debris or deposited soil. Road surfaces need to be good quality stable gravel that resists the forces of water and traffic.

See **6.0 GRADING**, and See **5.2 THE SURFACE**

In extreme situations it may be necessary to pave the road with hottop which, if properly installed over a well-drained, stable base should provide a near permanent solution. If hottop is installed over an inadequate base it can become a liability because it cannot be regraded in the event of surface breakup.

Culverts or ditches can wash out because of inadequate design, installation or maintenance.

See **8.0 GETTING WATER AWAY FROM THE ROAD**

Trying to reclaim soil that has washed from the road and reuse it as road surface material is folly. Whatever fines were present in the gravel have left with the stormwater, leaving little more than washed sand and gravel behind. It is reasonable to replace reclaimed material back in to a gully, but it should be covered with good gravel and the crown restored or the same situation will reoccur.

WINTER WOES:

SNOWPLOW DAMAGE: dug up roads, plow berms, crowns removed, etc

Cause: Overeager or careless snow removal before roads have frozen in the Fall, and particularly, after they have thawed in the Spring

Solution: Exercise care when plowing, have prearrangements to not have roads plowed under certain conditions, or plow with front mounted grader-rake instead of a conventional snowplow.

Snowplows, especially the trip-edge type so common here in the Northeast, are designed to cut under the snow and do not know the difference between snow and gravel. Plowing one late winter snowstorm can undo a whole season's improvements to a road, especially if plow damage goes unrepaired before spring rains take advantage of new channels made by the snowplow.

Ironically, many of these snowstorms would melt within a very few days if left alone. Therefore, the option exist for a road association to establish an agreement between road users and maintenance personnel as to when to avoid plowing because resulting damage may outweigh benefits.

Many of the towns and contractors who use front-mounted grader rakes for summer maintenance have found these units to be well suited to clear snow and slush from soft roads. Because the units are even useful for breaking up winter ice, the demand for traction sand can be reduced along with its detrimental effects on road surfaces and surface water.

See article: **SNOW REMOVAL WITH A FRONT RUNNER**

ICE DAM WASHOUTS: late winter or early spring gullies in the traveled way

Cause: unusual buildup of ice in the snowbanks alongside the plowed road keeping water from being able to run to the road ditches

Solution: Although there is no practical way to eliminate such ice dams, their effects can be reduced by cutting slots through the ice to the road ditch. This should be done as often as possible, especially on steeply sloping roads.

This particular problem seems to be the result of changing winters bringing more icy rains. If ice dams do start water washing down the road rather than to the road ditches before channels are opened up through the ice, it is important to create small dams in the water formed channels to force water into the new turn-outs or it will continue to wash down the road.

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