by Tom Kuennen, Contributing Editor

Manage Your Unpaved Roads for Best Value, Performance

Major changes in the way unpaved or gravel local roads are used means changes in how they are financed, maintained, and managed.

While unpaved or gravel roads may look like relics of the 19th century to urban motorists, they very much are part of the 21st century surface transportation infrastructure.

As such, how they are financed, maintained, and managed is changing, and that's a response to both external changes at the national and state levels, and changes in how they are employed by road users.

"Historically, states developed extensive road networks to support the agrarian lifestyle," said Jill Hough, Ayman Smadi, and John Bitzan, of the Upper Great Plains Transportation Institute, North Dakota State University, Fargo, in their paper, *Innovative Financing Methods for Local Roads in the Midwest and Mountain-Plains States*.

"Typically roads were built every mile to provide farm access," the authors wrote. "Changes in the agricultural sector are changing the demands placed on the rural road systems. First, the trend toward larger farms reduces the need for access roads," they said.

"Second, with the increased farm size, and the move to more productivity, there has been an increase in equipment size," the authors wrote. "The larger and heavier equipment requires wider and stronger rural roads.

"Third, [some] rural families earn off-farm income either seasonally or all year-round, which increases commuter traffic on rural roads," they said in the paper. "As the purpose of rural trips changes, the demands for improved maintenance increase."

Fourth, changes in railroad regulation have allowed the abandonment of rail lines more easily, they note. "Since 1980, more than 33,000 miles of rail have been abandoned nationwide," the authors write. "Commodities and other goods otherwise moved by rail may be diverted to truck or barge where applicable. The increased truck use causes additional wear and tear on the roadway. Many rural roads were not designed for the density and truck configuration of this traffic. Changes in available funding may make it even more difficult in the future to maintain the extensive road network that has been built

to serve the public.

Of the 4 million miles of public roads in the United States in 2006, the most recent year for which firm data are available, 1.4 million were unpaved, reports the Federal Highway Administration's *Highway Statistics 2006*. But some agencies rely on unpaved roads more than others. For example, more than one-half of North Dakota's 106,000 miles of road are gravel, which is one reason so much good research emanates from that state, along with neighboring South Dakota and Minnesota.

Unpaved road management software

Like the asset management systems for paved roads, systems exist that can be adapted to unpaved road management. For example, the University of New Hampshire T2 Center developed its Road Surface Management System (RSMS) to meet the management needs of small to mid-sized municipalities.

The RSMS is designed to effectively and inexpensively provide pavement management support for small to large-sized municipal agencies. The road management system is a comprehensive pavement management system tool to coordinate improvements and maintain quality systems through the efficient use of labor, material, and budget. The intentionally generic design provides the user with flexibility making it an excellent management tool. Data entry is rapid, which reduces costs. The graphical capabilities provide intuitive, easy to understand results and increased analysis capabilities.

A new update contains new analytical tools developed to ease maintenance and budget planning. With RSMS the local road manager are able to do the following:

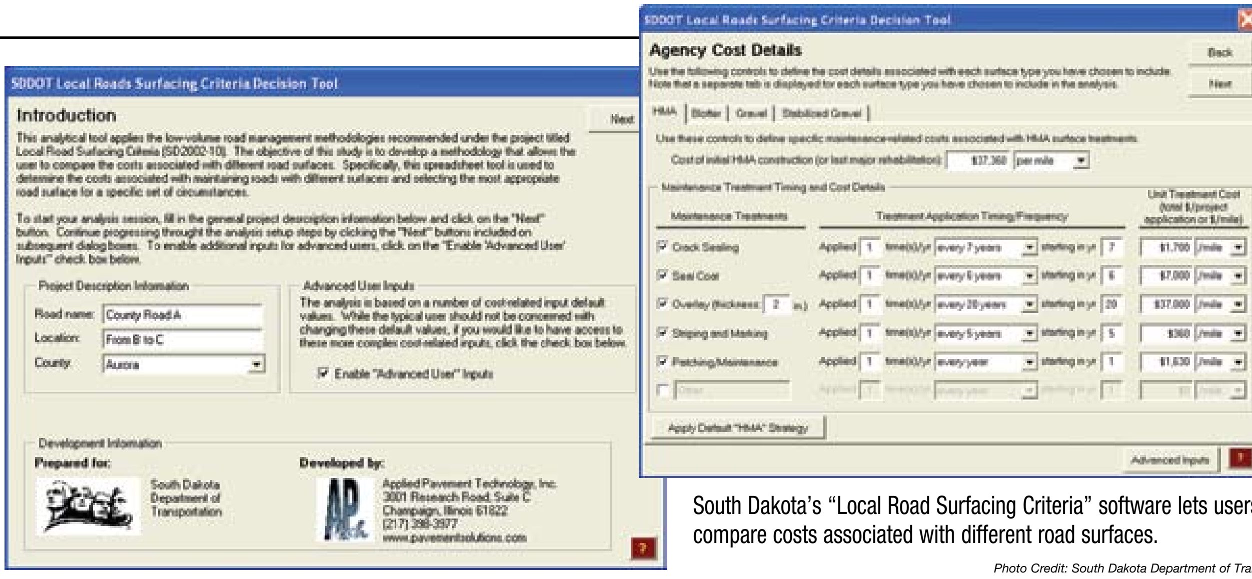
- Inventory its unpaved and paved roads;
- Determine and record surface conditions;
- Consider a number of alternative repairs for each road;
- Apply proven techniques and management principles; and
- Develop multi-year plans and budgets to maintain and repair local roads.

A central feature of RSMS is easy data collection and processing. To help users apply the management system, the University of New Hampshire T2 Center conducts a thorough, two-day workshop. Participants receive the trial version software program and documentation.

Establishment of a road inventory is the first concern in any pavement management system, and that's part of this system. The inventory lists all the roads and their characteristics, such as: name, location, length, width, and traffic volume.

The user rates the condition of the road based on the severity and extent of distresses visible on a roadway surface. This information is the basis to determine a plan for road improvement. Conditions are entered quickly for each road section by clicking on the map and completing the assessment form.

The road management system aids decision-makers by offering



South Dakota's "Local Road Surfacing Criteria" software lets users compare costs associated with different road surfaces.

Photo Credit: South Dakota Department of Transportation

suggested strategies to repair distresses identified in the condition assessment. It is flexible, allowing it to handle an almost unlimited number of surface types, distresses, and repair techniques and is pre-configured with common surfaces and repairs (information should be reviewed and modified as necessary to meet the needs of the municipality).

RSMS was developed by the University of New Hampshire in 1989 and distributed nationwide through Local Technology Assistance Program/Tribal Technology Assistance Program centers across the nation. The program was developed for low-cost distribution by government agencies and is non-profit.

South Dakota's Surface Criteria software

In the meantime, local road agencies face the question of how to cost-effectively maintain low-volume roads. Specifically, decision makers are faced with the challenge of determining when it is most economical to maintain, upgrade, or downgrade a road's existing surface.

In order to assist decision makers with these types of decisions, the South Dakota Department of Transportation initiated a research study in 2002 to investigate surfacing criteria for low-volume roads (LVR).

Its objective was to create a process that allows the user to compare the costs associated with different types of roads, and provide assistance in deciding which surface type (hot-mix asphalt, gravel, or stabilized gravel) is most economical under a specific set of circumstances.

In addition to incorporating economic factors into the analysis, the process also allows the user to consider other non-economic factors that are more subjective and difficult to quantify, such as political factors, growth rates, housing concentration, mail routes, and industry/truck traffic.

The underlying methodology developed during this project for making road surface type decisions is based upon life cycle cost-analysis (LCCA) techniques that focus on selecting the most cost-effective road surface to meet a specific need.

The primary deliverables include a technical brief that summarizes the manual procedure for determining the appropriate surface type for a road section based upon the average conditions, other documents, and a software tool that allows the user to analyze economic and non-economic factors at specific locations to determine the appropriate surface type. See the "For More Information" sidebar at the end of the article for downloading information.

A money shortage

How do owners of unpaved roads can adapt when there simply is not enough money to maintain the road system? The research paper titled, Innovative Financing Methods, referenced earlier, points out that "[L]ocal governments have relied on fuel taxes, property taxes, vehicle registration fees, and mill levies to finance road maintenance and improvements," Hough, Smadi and Bitzan write. However, the authors note that traditional funding sources are no longer adequate, and that there "is a great need for counties to explore innovative methods that increase revenue or decrease costs."

Worth noting in the research paper are eight innovative financing methods, such as rural improvement districts, and 14 cost-reducing strategies, for example, sharing equipment, that local governments in Iowa, Minnesota, Montana, North Dakota, South Dakota, Utah, and Wyoming were using.

Four innovative financing methods were identified to contribute significantly to the overall county road budgets, including a countywide sales tax, a special ownership tax, a wheel tax, and a rural improvement district tax. "Each of these methods would be relatively easy to administer and collect," the authors write. "However, public opposition may prevent any of them from being enacted into legislation."

Currently, the wheel tax and the rural improvement district tax are not widely used. "Only South Dakota counties reported the use of the wheel tax," the authors say. "South Dakota counties cannot implement a county fuel tax so they rely on the wheel tax to generate enough revenue for road improvements. The main criticism with the wheel tax is that it does not fairly tax the users of the road since each vehicle is taxed the same regardless of the weight or miles traveled."

One county in Montana reported the use of the rural improvement district and one county in North Dakota reported the use of a special assessment district. These methods are similar and may become more popular as counties become more urbanized through the development of additional subdivisions.

Five other potential non-traditional revenue-generating methods were identified. They included a severance tax, bond, traffic violation fines, cost participation, and a telephone tax.

"Implementing a severance tax is an attempt to claim revenues from sources that add extra wear and tear to the road system," the authors write. "Counties should closely examine if they have minerals or other products that justify implementation of a severance tax. Although bonds have been used frequently by governmental agencies to generate revenues, according to the survey responses, they do not appear to be widely used at the county level. However, bonds seem to be gaining popularity."

The collection of traffic violation fines is too uncertain for counties to rely on them as a steady source of income, they said. The use of a telephone tax is a non-user based tax and does not benefit the individuals paying the tax.

Cost-reducing strategies are equally important for counties to consider increasing road funds.

"Reducing costs is the result of managing services and resources more efficiently," they said. "County road officials identified 14 cost reducing strategies in the questionnaire. Using chemical additives, reducing maintenance, and closing roads were some of the service strategies identified."

ROAD SCIENCE

Maintaining the unpaved road

Gravel road maintenance includes roadside maintenance, grading, ditching, snow and ice control, signing, dust control, rehabilitation/regrading, and other steps.

"Road Science" recently took a graphic look at unpaved road maintenance in *Better Roads'* November 2008 issue (see "Road Science Illustrated: Maintaining Unpaved Roads," pages 37-40). And while it may not take much to lower the condition of an unpaved road, it doesn't take much to bring them up to par, either.

"Given some sunshine, wind, and a reasonably skilled motor grader operator, they can be put back into a passable condition for a fraction of the cost of failed paved roads," said unpaved road guru Ken Skorseth, program manager for the South Dakota Local Technology Assistance Program, more commonly called LTAP.

"Water is a big issue, and because of that, so is the crown of the road," Skorseth says. "It's critical to understand the crown; If you use the same crown with unpaved roads as you do with pavements you will invariably have trouble, because you cannot drain water off an unpaved road with only 2 percent crown, used universally for pavements."

Instead, these roads need a higher crown than paved roads, Skorseth tells *Better Roads*. "Gravel or unpaved roads generally perform best with a crown at or near 4 percent," he says. "It's a drainage issue; you can't get water off an aggregate surface with only 2 percent crown, and they won't perform well."

And good drainage is even more critical for dirt roads than for paved roads. "When you get graded earth without any aggregate surfacing, adequate drainage is more critical than at any other time," he says.

Shoulders and ditches also are essential. "Along with the crown, shoulder and ditch drainage is even more critical with gravel roads than paved roads, although obviously pavements will fail if you can't keep water away from them," Skorseth says.

The way non-cohesive gravel moves about the surface of an unpaved road also will slow drainage from the road. "Gravel roads will develop a 'berm,' or windrow of loose aggregate along the edge of the traveled way, and that will restrict drainage," Skorseth says. "This comes from two sources: Either from poor or careless use of a motor grader in maintenance, in which aggregate is lost off the toe of the moldboard; or from poor surface aggregate in place, which keeps shifting to the sides of the roadway, and can't be recovered. Both are huge problems for drainage of unpaved roads and will lead to what engineers call a 'secondary ditch' along the sides of the road."

Managing unpaved road loss of fines

Dust is generated as an unpaved surface dries out and is disturbed by traffic. Periodic blading of an unpaved road surface several times a year, though needed to maintain a crown and eliminate ruts and holes, also has the effect of loosening aggregate and fines.

The more dust that leaves on your road surface, the less road surface that remains. As dust departs, aggregates and other fines loosen, leading to surface woes and costly replacement with new gravel.

Dust can be controlled by periodic distribution of water, by establishment of a dust-suppressive, moisture-absorbing crust on a road surface, and by best management practices.

Water is a dust suppressant of first resort, but is not long-lived in the summer. Dust palliatives are an alternative to water. They can be used to suppress dust on a driving surface, keeping moisture in the road, and actually absorb humidity from the ambient air, further suppressing dust.

Chemical road treatments or palliatives work to keep dust in control. There are too many to list, but generic examples of these chemical palliatives include anionic asphalt emulsions, latex emulsions, resin-water emulsions, and old familiars such as calcium chloride. When considering chemical palliatives for dust suppression, the agency should ascertain whether the chemical is biodegradable or water-soluble, and what effect its application could have on the surrounding environment, including water bodies and wildlife.

In their study, "Chemical Additive Usage on Unpaved Roads in the Mountain Plains States," Birst and Hough of the Upper Great Plains Transportation Institute found that soil stabilizers and dust suppressants may help to reduce the need and demand for gravel in an age of shortages in quality gravel.

"Many products are available on the market to stabilize the soil or reduce dust," they said. "However, not all of these products will work on every soil type." Birst and Hough surveyed county road officials about their use of chemical additives to stabilize the soil and reduce dust. Questionnaires were mailed to each of the county engineer or road supervisors in Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.

"According to the survey results, 60 agencies used 90 chemical additives for dust control and soil stabilization," they said. "Of the categories identified, the chloride additives were the most widely used (64 percent), while the clay additives, bituminous binders, and adhesives were used by 18, 8, and 6 percent, respectively, of

Slurry surfacing helps unpaved haul roads stand up to heavy truck traffic.

Photo credit: VSS Macropaver

Dual reclaimer/recyclers stabilize water-saturated desert soil for unpaved road right-of-way along the New Mexico-Chihuahua border where a fence is under construction between United States and Mexico.

Photo credit: Wirtgen America, Inc.

the respondents. Most of the agencies that used chemical additives stated that they had success with the products."

Stabilizing haul road surface

As unpaved roads endure heavier and heavier loads from agriculture and industry, they may need more robust dust palliative treatments. And nowhere do unpaved roads get more heavy loads than quarries and open pit mines.

The largest gold mine in South America — the Yanacocha Mine in the Andes Mountains near Cajamarca in northern Peru — is using slurry surfacing on its compacted, unpaved roads to reduce fugitive dust from access roads in summer, and mud in winter, while greatly reducing water consumption for road dust control.

The result is greatly curtailed particulate emissions, which can impact the health of neighboring residents, and enhanced visibility, which makes roads safer and reduces regional haze.

Winter's muddy roads are eliminated, which reduces erosion and non-point water pollution. And in an arid, mountainous region, the mine is saving hundreds of thousands of gallons of water each year that no longer must be distributed to suppress dust along the access roads. Moreover, the asphalt emulsion used in the slurry is environmentally friendly, with no volatile organic compound (VOC) emissions.

All of this is very important as Yanacocha operates under heavy scrutiny from its neighbors and from environmental agencies.

The mine began dust control on its roads after 1997, when exces-

Instead of paving road to hold up to traffic, Chisago County, Minn., stabilizes unpaved road using asphalt emulsion.

Photo credit: Wegman, Dahlberg, Bray, Lukanen, Thomas sive road dust led to a government citation. As a result the company spent as much as $1.5 million a year on dust suppression using water. However, water is scarce. All the communities near the mine are agricultural-based and must share the water supply with the mine, and the mine's putting extra water on the road for dust suppression was not popular. After field experiments the mine settled on the slurry coating for its unpaved roads.

Yanacocha is using Bitusoil agglutinized asphalt emulsion in the slurry surfacing from Bituper S.A.C., Lima, and is placing it using the Macropaver Model 12B slurry machine from VSS Macropaver, a division of Reed International, Hickman, Calif. Bituper purchased the 12B Macropaver in October 2006.

"The [emulsion] product used is highly ecological, does not impact the environment, and performs at lower cost," said Victor A. Lopez Chegne, Bituper technical manager, in a presentation at Peru's VI National Mining Congress in December 2006. "The quality of service was beyond expectations."

At the Mining Congress, Bituper's Lopez Chegne elaborated on requirements for a successful placement of slurry over an unpaved road. "The horizontal and vertical geometry layout ought to be coherent," he said. "The granular base must be properly consolidated with a California Bearing Ratio of over 90 percent. The drainage system ought to be adequate, and the width of the roadway ought to be, if possible, no less than 6 meters [19.6 feet]." The mine access roads generally were 9 meters [29.5 feet] wide.

Stabilizing unpaved right-of-way

Sometimes water is all that is needed to stabilize the right-of-way for an unpaved road. Working to a tight end-of-2008 deadline, and using only water, two soil stabilizers were consolidating the foundation, and alongside access road, of the fence under construction along the United States-Mexico border.

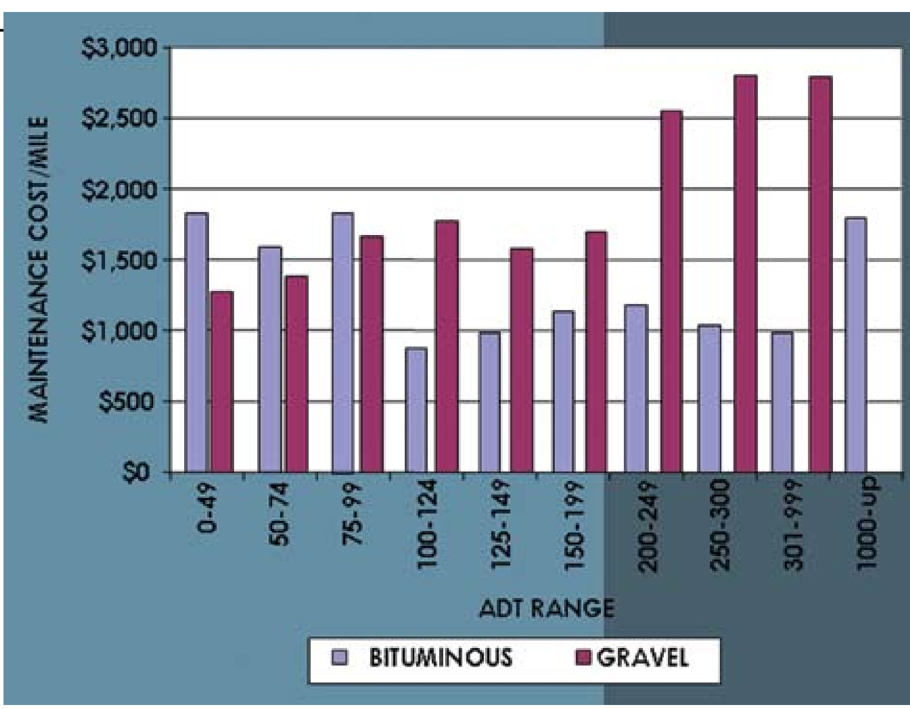
The machines were working on a 46-mile section of the fence from west of Santa Teresa, N.M., west toward Columbus, N.M., and operating in a 32-ft.-wide corridor.

In order to place the prefabricated fence sections, the access road has to be stabilized; if the fence were placed on unstabilized sand, it would just sink in over time. Instead, one or more passes were being made with the reclaimers, and 92 percent density was attained after compaction.

The unpaved access road itself will consist of the existing sand/soil/clay mix, stabilized in situ 10 inches deep with water and compacted, then topped with a stone base course layer. Where the road and fence cross a dry arroyo, crushed stone layers with geotextile, topped with a mat made of linked pre-cast concrete cells, will form a ford.

Water was being injected using 1,800 liter-per-minute pumping systems installed on both of the WR 2000 XL recycler/reclaimers from Wirtgen America, Inc., and was supplied by tanker trucks. However, in some locations, where the sand was so loose tanker trucks could not be hooked up and pushed through, water supplied by sprinkler trucks was providing enough moisture to get compaction.

To smooth the way, motor graders were being used both ahead of and behind the stabilizers, in conjunction with the compactors.



An increase in traffic leads to an increase in maintenance costs, especially for gravel roads, due to more lost gravel due to wear, and an increased need for blading and smoothing of the road surface.

Photo credit: Ann Johnson, University of Minnesota.

Strengthening base instead of paving

If paving is too expensive of an upgrade option, strengthening the base might be acceptable. That's what Chisago County, Minn. found a few years ago, as described in the 2004 Transportation Research Board paper, *A Strong but Flexible Foundation for*

Chisago County, by Dan Wegman, Mic Dahlberg, Ron Bray, Erland Lukanen, and Todd Thomas.

"Chisago County, like many other counties in the U.S., has a limited budget and many miles of gravel roads that need ever increasing expenditures to maintain their current condition," the authors wrote. "Paving would greatly increase the value of this infrastructure to both road owner and road users. However, conventional design and construction methods are too expensive or do not give the needed performance."

Instead, a team of the county engineer, consultants, a supplier, and a contractor developed a cost-effective method for upgrading Chisago's granular material roads and reducing maintenance costs. An existing gravel road was analyzed and sampled. An emulsion stabilized base mix was designed using performance-related techniques adapted for emulsion mixes. Structural design was performed with traffic, soil and falling weight deflectometer data.

The existing gravel is mixed with an asphalt emulsion formulated for optimal coating and curing as well as the desired strength and resistance to thermal cracking. After construction, the newly stabilized base could be overlaid with a thin, specially engineered surface mixture or sealed with a chip seal to protect the stabilized base from moisture and to improve surface texture.

When to pave the unpaved

Paving of an unpaved road can elevate the road to higher service levels and satisfy local voters. But because the costs of maintaining unpaved roads are so low, and that they can serve a limited number of vehicles so well, agencies should think twice before they commit to paving an unpaved road.

"Too often we bow to public pressure to pave an unpaved road, without a real commitment to design of a good pavement, and without an adequate budget," Skorseth said. "Quite honestly, all we do is trade gravel road maintenance problems for asphalt road maintenance problems. And then, asphalt road maintenance problems are so much more costly to repair, especially as you get deeper into the life cycle."

Nonetheless, the consideration of whether to improve got a lot easier in October 2006, when products developed by Ann Johnson, Department of Civil Engineering, University of Minnesota, became available.

Johnson researched the issue of how and why to upgrade a gravel road and developed the presentation, "To Pave or Not to Pave? Making Informed Decisions on When to Upgrade a Gravel Road." It helps the engineer with necessary economic, political, and social information when considering an upgrade on local roads. Its format allows the engineer to easily share the information with employees, local boards, citizens, and others who weigh in on the decision.

The presentation is designed to supplement current Minnesota LTAP gravel road training materials, and is based on the findings of two reports, South Dakota's *Local Road Surfacing Criteria* documents and software, and Minnesota's "Cost Comparison of Treatments Used to Maintain and Upgrade Aggregate Roads."

These reports detail reasons to pave as well as reasons to hold off, provide a tool to simplify the decision-making process, and also provide information including cost

For More Information

A cornucopia of information on unpaved road management is available to the road manager. Here is a selection of just some of those links.

■ The South Dakota LTAP's seminal publication, *Gravel Roads: Maintenance and Design Manual*, produced in association with the Federal Highway Administration, may be downloaded in chapters, or the complete 38 megabyte document, from the U.S. Environmental Protection Agency's Web site at *www.epa.gov/owow/nps/gravelroads/*.

■ The end of winter brings new challenges, as roads thaw even as farmers begin to move heavy equipment on them in advance of spring planting. The guidebook *Improved Performance of Unpaved Roads During Spring Thaw*, published in February 2005, is available from the U.S. Army Corps of Engineers at *www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/TR05-1.pdf*.

■ The Federal Highway Administration publication, *Planning for Transportation in Rural Areas*, contains advice on multi-modal solutions as well as unpaved road management, and is available online at *www.fhwa.dot.gov/Planning/rural/planningfortrans/index.html*.

■ The Environmental Protection Agency's November 2006 overview of particulate emissions from unpaved roads is available at *www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf*.

■ The University of New Hampshire's T2 Center developed the Road Surface Management System to meet the management needs of small to mid-sized municipalities. This update contains new analytical tools developed to ease maintenance and budget planning. Find out how to obtain the tools at *www.t2.unh.edu/software.html*.

■ A companion Technical Brief to South Dakota's Local Road Surfacing Criteria software may be downloaded from the South Dakota Department of Transportation, at *www.state.sd.us/Applications/HR19ResearchProjects/Projects%5CSD200210_Technical_Brief.pdf*.

■ The Minnesota LTAP site's *Erosion Control Handbook for Local Roads (2003)* assists counties, townships, and local units of government by providing guidelines and methods for effective erosion control practices on low-volume roads. Download it at *www.mnltap.umn.edu/pdf/erosioncontrolhandbook.pdf*.

■ The Massachusetts Unpaved Roads BMP Manual is an essential guide that focuses on water control. Download it at *www.berkshireplanning.org/4/download/dirt_roads.pdf*.

■ The U.S. Army COE's technical manual, *Unsurfaced Road Maintenance Management*, by Robert E. Eaton and Ronald E. Beacham (1995) may be downloaded at *www.crrel.usace.army.mil/library/specialreports/SR92_26.pdf*.

■ The unpaved road management study, *Guidelines for Consolidating Township Roads: A Case Study Showing Benefit/Cost Analysis for Closing Township Roads in North Dakota*, may be downloaded at *www.mountain-plains.org/pubs/pdf/MPC99-102.pdf*.

■ Another publication of the *Upper Great Plains Transportation Institute, Innovative Financing Methods for Local Roads in the Midwest and Mountain-Plains States*, may be downloaded at *www.mountain-plains.org/pubs/pdf/MPC97-74.pdf*.

■ And the institute's publication, *Chemical Additive Usage on Unpaved Roads in the Mountain Plains States*, which discusses how western states use chemicals to stabilize unpaved road surfaces to reduce dust loss, enhance performance, and eliminate the need for additional gravel is available at *www.ugpti.org/pubs/pdf/DP130.pdf*.

■ The Federal Highway Administration publication, *Highway Statistics 2006*, was produced in October 2007 incorporates the most recent data available on expenditures, surface types, condition, and much more, on both a national and state-by-state basis. *Highway Statistics 2008* should supplant it this year, but in the meantime, you may browse the 2006 stats at *www.fhwa.dot.gov/policy/ohim/hs06/*.

■ The October 2006 publication from Minnesota, *To Pave or Not to Pave? Making Informed Decisions on When to Upgrade a Gravel Road* can be downloaded — along with multimedia presentations, other documents, and more information about South Dakota's Local Road Surfacing Criteria documents and software — at *www.mnltap.umn.edu/KnowHow/Topics/LowVolumeRoads.html*.

analysis based on historical spending for low-volume roads, a method for estimating cost of maintenance and construction specific to an engineer's area, and an economic analysis using data such as present-worth evaluation.

A link to these documents and presentations is provided in the sidebar on page 38, and is well worth the visit.

Future costs paramount in pave decision

Future costs are the basis of the decision to pave an unpaved gravel road, according to the 2006 Transportation Research Board paper, "Deciding When to Pave an Aggregate Road," by Dr. Charles T. Jahren and Dr. David White, Iowa State University, and Duane Smith, Center for Transportation Research and Education at the university.

They used two approaches are used for estimating future costs. "The first is a historical cost analysis based on the spending history for low-volume roads found in the annual reports of selected Minnesota counties," they said. This included the effects of traffic volume and type of road surface on cost.

"The second is the development of a method for estimating the cost of maintaining aggregate roads, which is useful when the requirements for labor, equipment and materials can be predicted," the authors wrote, including maintenance grading, regraveling, dust control/stabilization, reconstruction/regrading, paving, and others."

They presented a case study that compared the cost of maintaining a gravel road with the cost of upgrading to a paved surface, concluded that paving gravel roads should be considered an investment that will mostly reap rewards that do not result in monetary savings to the government agency. However, neighbors and road users might benefit from an improved quality of life, and economic development may follow resulting in some increase in property tax collection.

Earlier, the University of Kentucky's Kentucky Transportation Center adapted an essay from the Vermont Local Roads Program of St. Michael's College, which states the issues succinctly. Ten questions must be answered, the center says, stating unpaved roads should be paved only when meeting the following criteria:

- After developing a road management program;
- When the local agency is committed to effective management;
- When traffic demands it;
- After standards have been adopted;
- After considering safety and design;
- After the base and drainage are improved;
- After determining the costs of road preparation;
- After comparing pavement costs, pavement life and maintenance costs;
- After comparing user costs; and
- After weighing public opinion.

"Traffic volume and weight directly affect road longevity," says Marisa DiBiaso of the New Hampshire Technology Transfer Center. "The New Hampshire DOT recommends that roads with less than 50 average daily traffic (ADT) be unpaved. For ADT over 200, the DOT recommends an asphalt paved surface. For roads between 50 and 200 ADT, road managers should consider vehicle weights and past performance. If the unpaved road is performing well, with reasonable maintenance costs, paving is rarely justified. They should, however, consider applying a dust suppressant, which will also stabilize the road surface." **BR**