Managing Gravel Road Maintenance

TRB Webinar – April 10, 2012

Presented by:

Mr. Ken Skorseth, Program Manager

SD Local Transportation Assistance Program (LTAP)
South Dakota State University
Brookings, SD

Managing Gravel Road Maintenance

Brief background of presenter:

Overview of Seminar

- Roadway Shape & Drainage
  - Crown.
  - Avoiding High Shoulders.
- Surface Gravel Selection.
- Preservation of Gravel

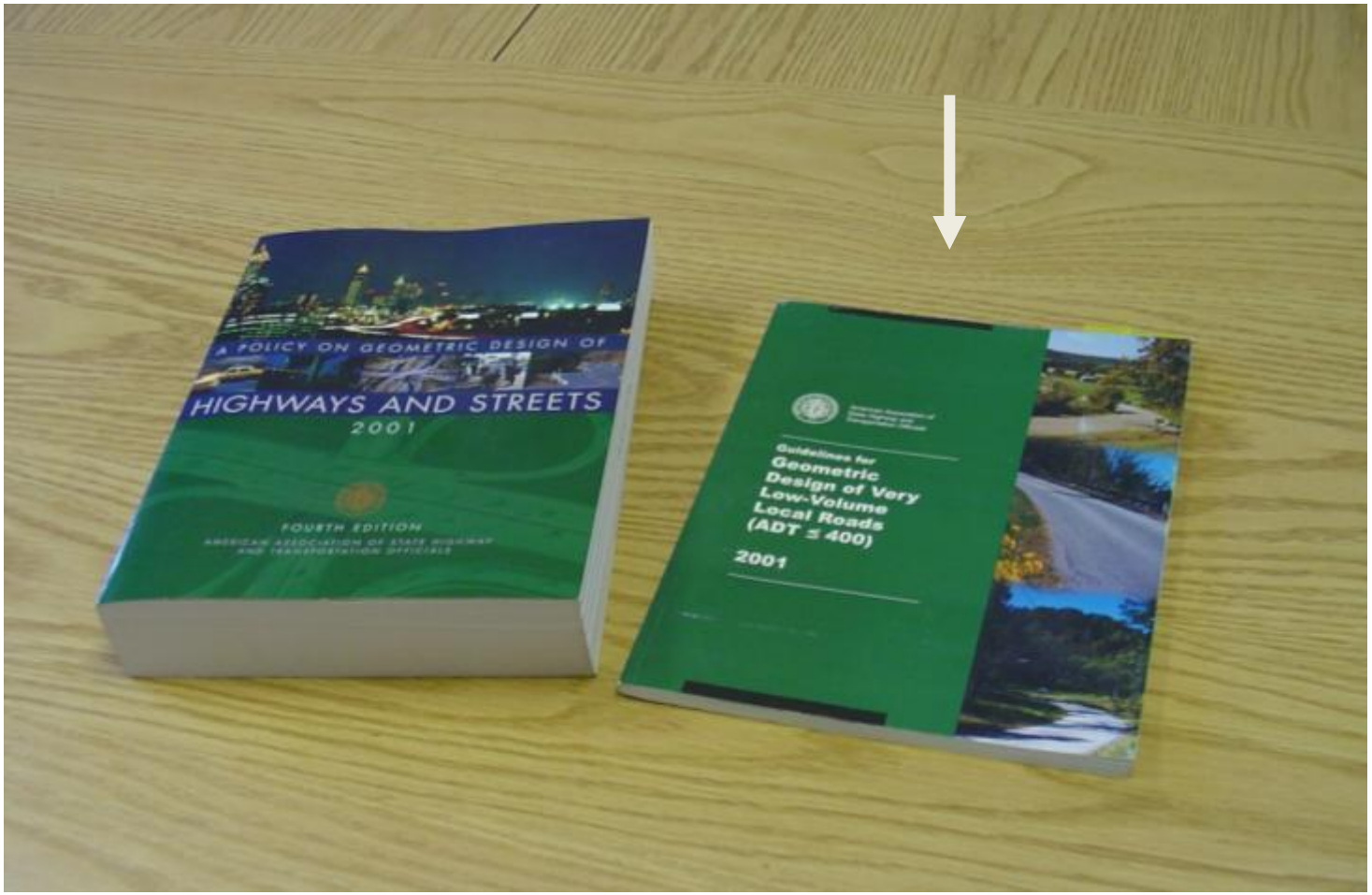
Design Issue – Basic Geometrics:

- Be familiar with the AASHTO publication: *Geometric Design of Very Low-Volume Local Roads* (ADT ≤ 400)

- Commonly called the "Little Green Book".

Managing Gravel Road Maintenance

Green Book and "Little Green Book"



"Nearly 80% of the roads in the US have traffic volumes of 400 vehicles per day or less."!! (quote from Little Green Book)

It becomes very difficult to construct and maintain these very low-volume roads to a high geometric standard.

Managing Gravel Road Maintenance

Guidelines for Total Roadway Width for New Construction of Very Low-Volume Local Roads in Rural Areas

From: AASHTO – Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤400)

Design speed (km/h)	Major access	Minor access	Recreational & scenic	Industrial/ commercial access	Resource recovery	Agricultural Access
15	-	18.0	18.0	20.0	20.0	22.0
20	-	18.0	18.0	20.0	20.0	24.0
25	18.0	18.0	18.0	21.0	21.0	24.0
30	18.0	18.0	18.0	22.5	22.5	24.0
35	18.0	18.0	18.0	22.5	22.5	24.0
40	18.0	18.0	20.0	22.5	-	24.0
45	20.0	20.0	20.0	23.0	-	26.0
50	20.0	20.0	20.0	24.5	-	-
55	22.0	-	22.0	-	-	-
60	22.0	-	-	-	-	-

Note: Total roadway width includes the width of both traveled way and shoulders.

Managing Gravel Road Maintenance

Guidelines for Total Roadway Width for New Construction of Very Low-Volume Local Roads in Rural Areas

From: AASHTO – Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT <400)

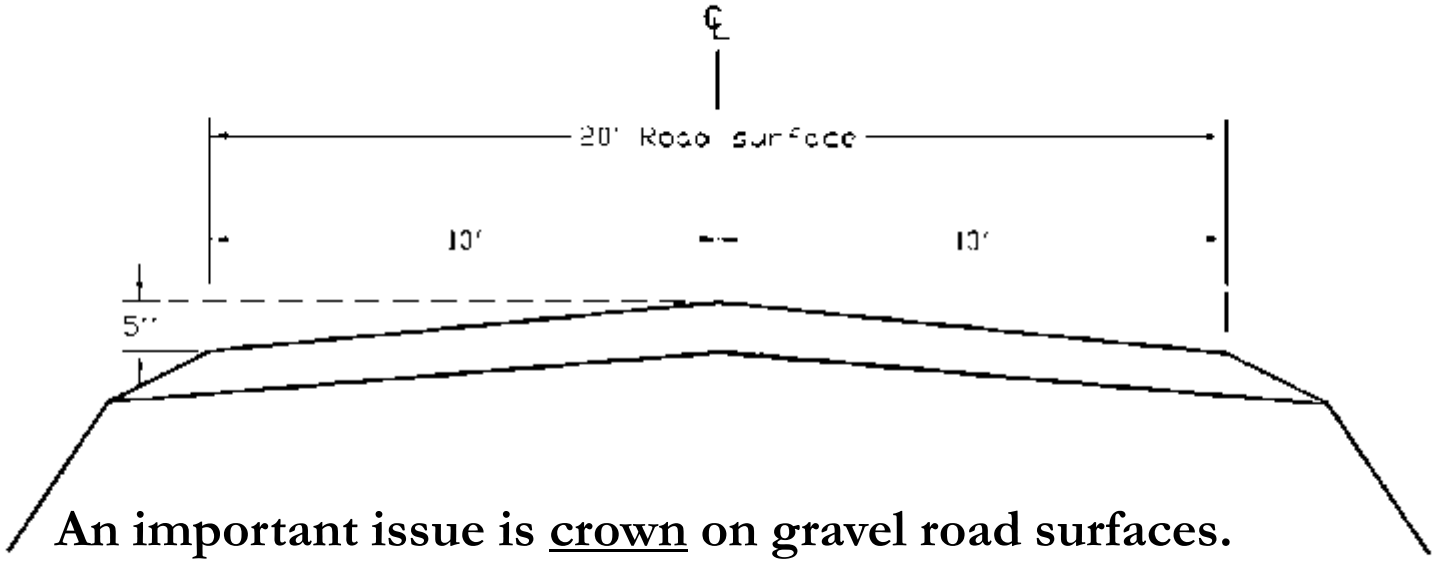
Design speed (km/h)	Major access	Minor access	Recreational & scenic	Industrial/	Resource	Agricultural ess
15						22.0
20						24.0
25						24.0
30						24.0
35	18.0	18.0	18.0	22.5		24.0
40	18.0	18.0	20.0	22.5	-	24.0
45	20.0	20.0	20.0	23.0	-	26.0
50	20.0	20.0	20.0	24.5	-	-
55	22.0	-	22.0	-	-	-
60	22.0	-	-	-	-	-

Note: Total roadway width includes the width of both traveled way and shoulders.

Lowest guideline: Major access requiring roadway width of 20 ft at design speed of 45 mph

Highest guideline: Agricultural access requiring roadway width of 26 ft at design speed of 45 mph

Roadway Crown



An important issue is <u>crown</u> on gravel road surfaces. Generally recommended crown for gravel surfaces is 4% which is double the crown used in pavements.

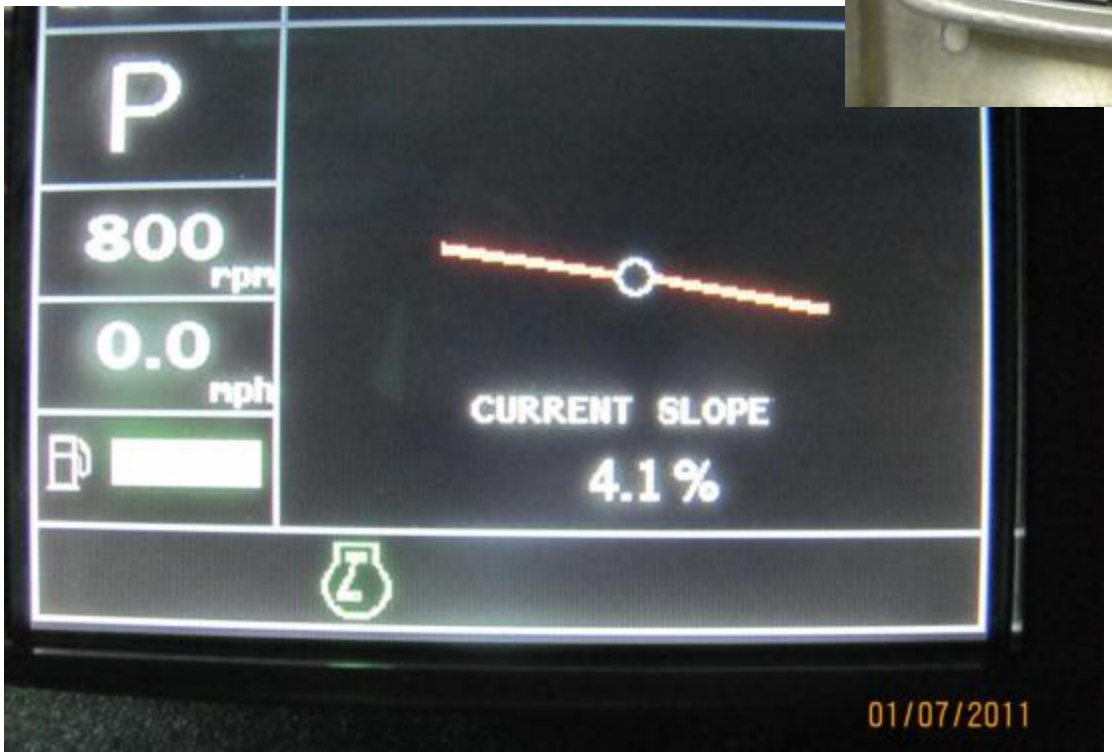
Crown: (con't)

Clear illustration of 2% crown on road to the left and 4% on the road to the right. Water will not drain off an aggregate surface with only 2% crown. This must be addressed in design and during construction.

Managing Gravel Road Maintenance

Some roads have too little crown, some have <u>too much.</u>

Managing Gravel Road Maintenance



Crown gauges are Helpful

Crown: (con't)

There are conflicting views on crown:

- 1/3 to 1/2 in. per ft. recommended by NACE manual *Blading Aggregate Surfaces – 1986 edition.*

- 2 to 6% for "low-type pavements" recommended by AASHTO Green Book pg 387 – 2001 edition.

Crown: (con't)

- The FHWA *Gravel Roads Manual* recommends crown at or near 4%.

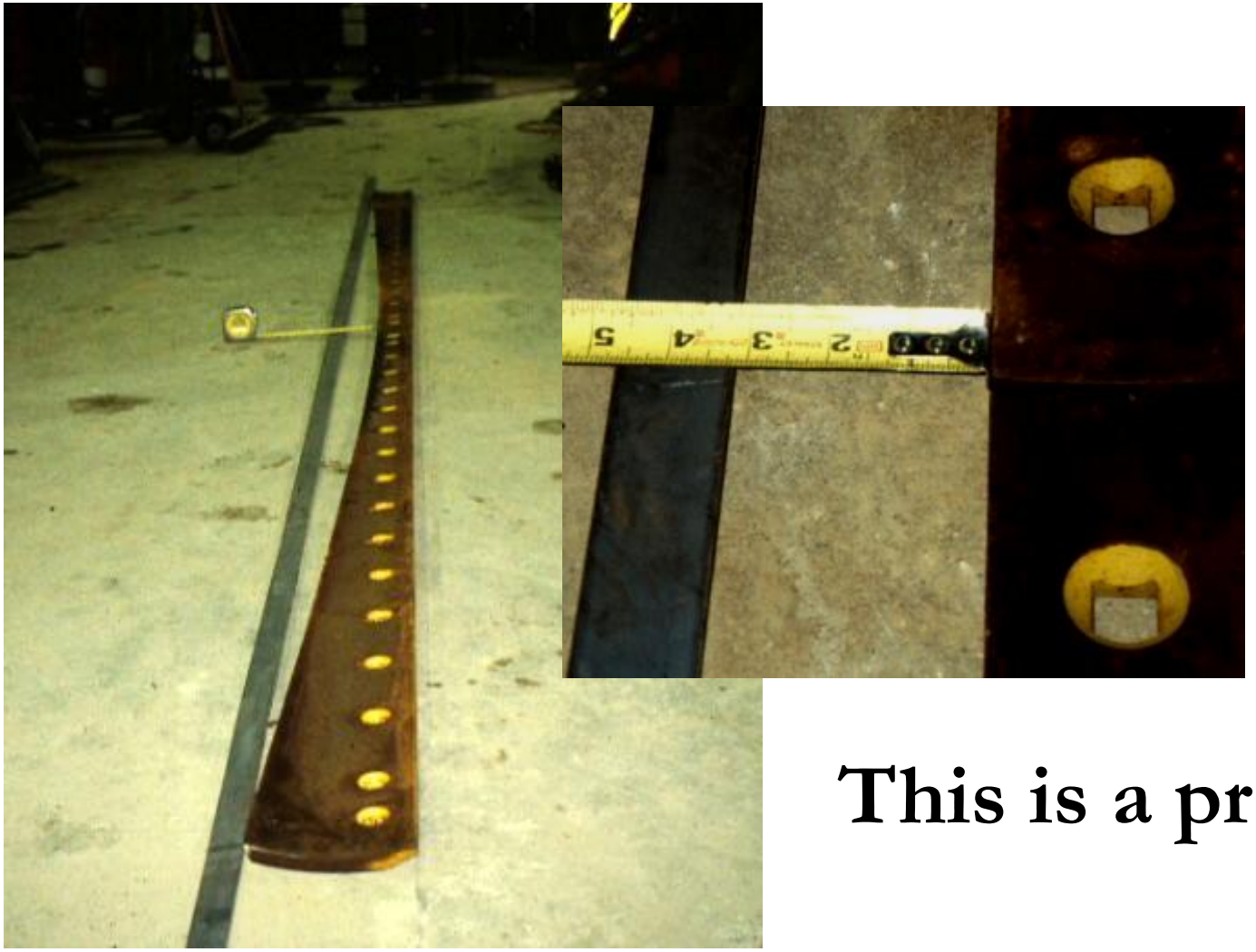
Note: in arid and semi-arid regions, gravel roads may perform with less crown, but don't use less than 3 %.

Maintaining Roadway Shape:

- Perhaps the most critical issue is keeping cutting edges straight.
- Many operators do not understand the importance of this and/or do not know how to control it.

Managing Gravel Road Maintenance

Center wear in the cutting edge

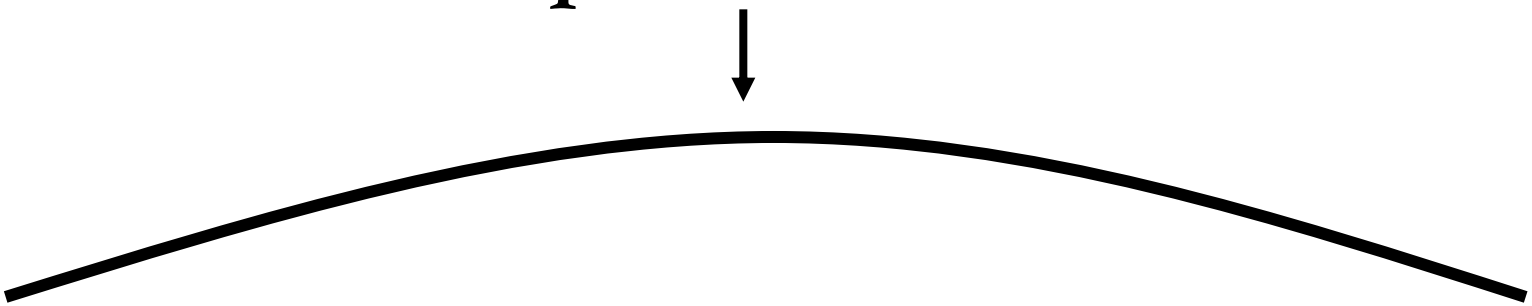


This is a problem!

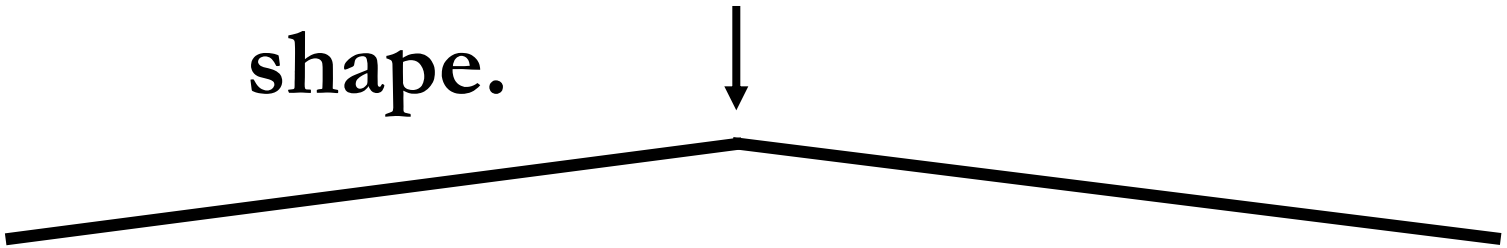
Managing Gravel Road Maintenance

Center wear in the cutting edge

Creates a parabolic crown.



Instead of correct shape.



Managing Gravel Road Maintenance

Once roads develop parabolic shape, it becomes hard to change.

This center wear occurred after only six hours of use on a badly shaped road!!

Reducing center wear in the cutting edge

Potential solutions: carbide cutting edges or bits.

Gravel Roads – Managing Maintenance

Frequency of blade maintenance:

- Should be managed by observing surface condition, not just by calendar date.
- Don't delay blade maintenance until surface distress becomes severe.

Gravel Roads – Managing Maintenance

Frequency of blade maintenance (con't)

- In areas of high moisture, vegetation will creep onto traveled way if blade maintenance is delayed.
- A good program of shoulder mowing is essential to gravel road maintenance.

Gravel Roads – Dealing with high shoulders

The high shoulder which obstructs drainage – a real problem on too many roads.

Managing Gravel Road Maintenance

Problem created by high shoulder

Managing Gravel Road Maintenance

Aggressive shoulder maintenance

Innovative tools to help reshape the high shoulder and recover gravel.

Managing Gravel Road Maintenance

Management Issue – Surface Gravel

- The issue of good surface gravel (aggregate) cannot be emphasized enough!!
- Good aggregate surfacing differs from base and other construction aggregates.
- When it's right, problems diminish!

Surface Gravel (con't)

Material Specifications Discussion:

- Many state DOTs do not have a surface aggregate spec.
- Many specifications that do exist are quite loose and do not allow close enough control of gradation.

Surface Gravel (con't)

Too often, surface aggregate is perceived as not important, hence quality suffers.

In study completed in Canada in 2003 – samples were taken from several aggregate supplier's stockpiles being marketed as surface aggregate--- **(con't next slide)**

Surface Gravel (con't)

Only 14% of the samples met the companies own specifications when tested by independent labs! Quality control was almost nonexistent.

Information from Material and Performance Specifications for Wearing Course Aggregates on Forest Roads **by G. Legere & S. Mercier.**

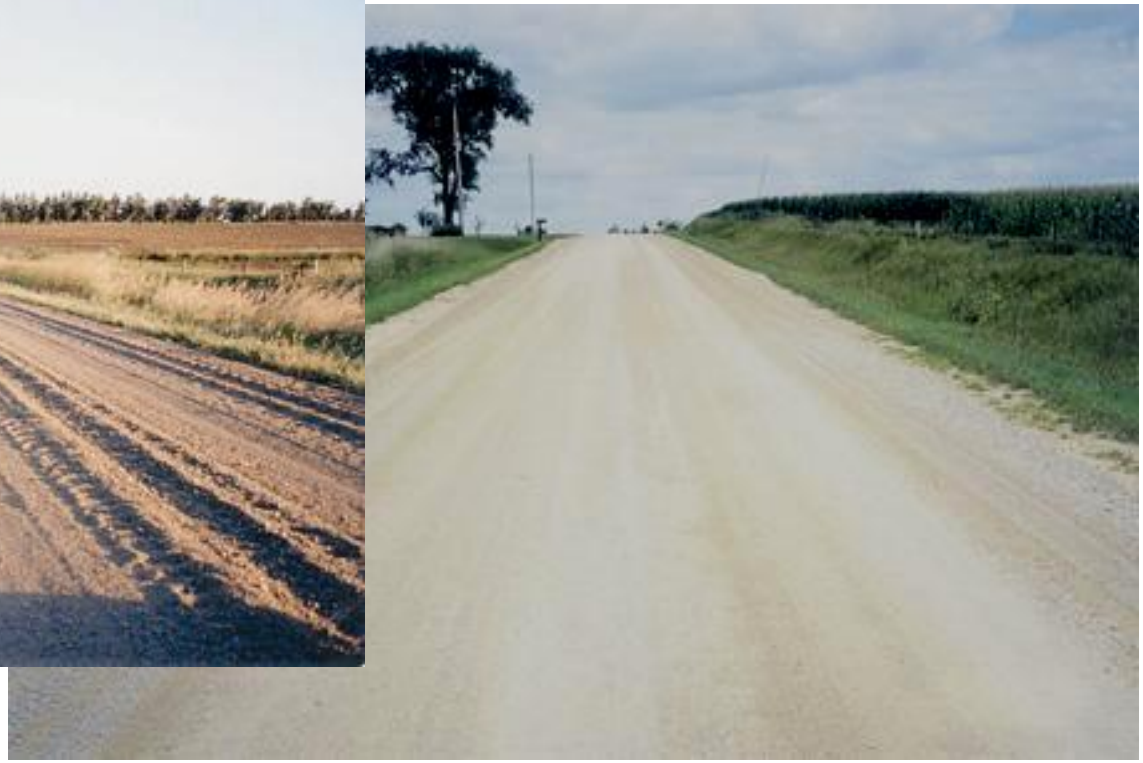
Surface Gravel (con't)

Surface aggregate differs from base aggregate in two fundamental ways:

- The need for more plastic fines to serve as binder.
- Smaller top-sized stone that will remain embedded in the surface.

Surface Gravel (con't)

Similar ADT, Similar geometrics, but different surface materials!



Surface Gravel (con't)

Corrugation or "washboarding" which is surface distress that is directly related to surface aggregate specification

Surface Gravel (con't)

Sample specifications comparison:

Table 1. Example of Gradation Requirements and Plasticity for Two Types of Materials.

Requirement Sieve	Aggregate Base Course Percent Passing	Gravel Surfacing Percent Passing
1"	100	
3/4"	80-100	100
1/2"	68-91	
No. 4	46-70	50-78
No. 8	34-54	37-67
No. 40	13-35	13-35
No. 200	3-12	4-15
Plasticity Index	0-6	4-12

From *South Dakota Standard Specifications.* (16)

Better when modified to 8 - 15

Surface Gravel (con't)

Another sample spec:

WisDOT CRUSHED AGGREGATE SHOULDER COURSE

Gradation No. 3

SIEVE SIZE	CRUSHED GRAVEL	CRUSHED STONE
1 inch	100	100
3/4 inch	95 -100	95-100
3/8 inch	50 - 90	50-90
No. 4	35 - 70	35-70
No. 10	20 - 55	15-55
No. 40	10 - 35	-
No. 200	9 - 15	5 - 15

Surface Gravel (con't)

AASHTO's Materials Manual – 2001 edition, Designation M-147 has these recommendations:

"Where it is planned that the soil aggregate surface course is to be maintained for several years without bituminous surface treatment-----, the engineer should specify a minimum of 8% passing the----No. 200 sieve----, and should specify a maximum liquid limit of 35 and plasticity index range of 4 to 9 in lieu of the limits given in Section 2.2.2.

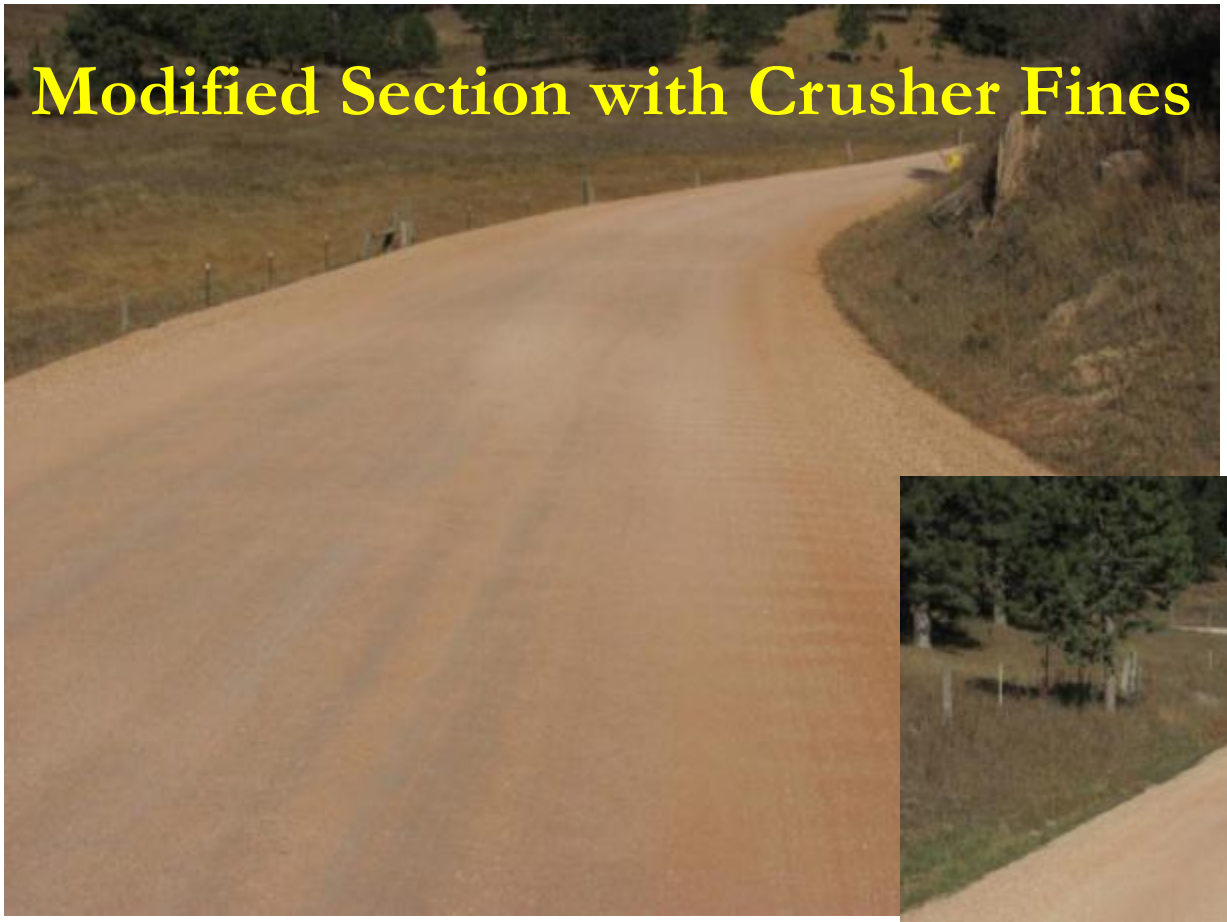
Managing Gravel Road Maintenance

- **Preservation of gravel – conserving a precious resource**
  - **High quality surface gravel results in lower life cycle cost**
  - **Reduction of aggregate loss**
  - **Reduced frequency of blade maintenance**
  - **Stabilization may be very cost effective if traffic volume is high**

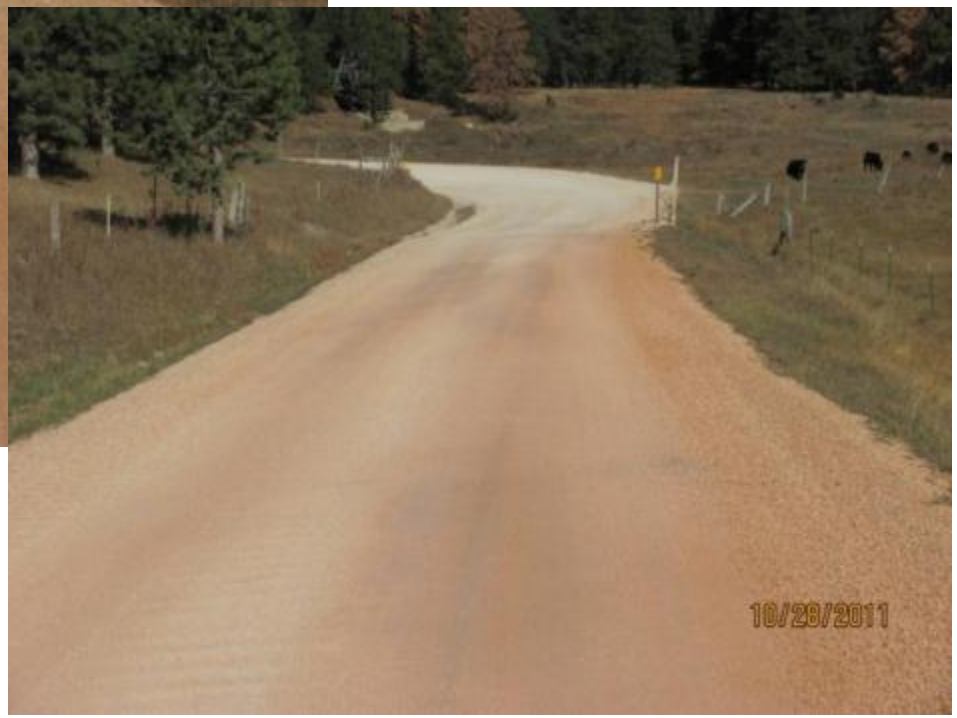
Current SDDOT Gravel Road Test Project

- **Three test sections:**
  - **Hand County – northeast of Miller**
  - **Custer County – northwest of Custer**
  - **Brookings County – south of Volga**
- **<u>Primary focus is on three gravel types</u>:**
  - **Substandard but commonly used**
  - **Meets SDDOT Gravel Surfacing Spec**
  - **Modified SDDOT Spec – higher minimum on percent passing #200 sieve and PI.**

Managing Gravel Road Maintenance



Crusher fines were added and mixed on road



Custer County Test Sections

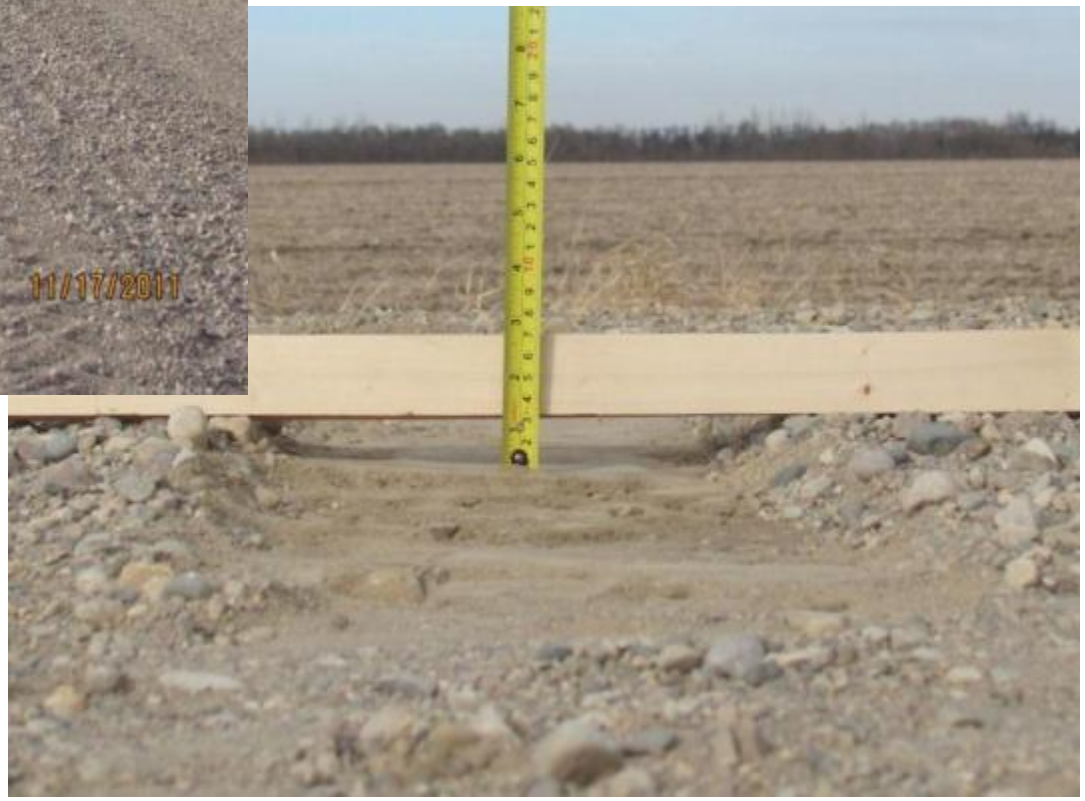
Managing Gravel Road Maintenance

Substandard section with crushed limestone commonly used by USFS

Custer County Sections (con't)

Managing Gravel Road Maintenance

Only one month after construction with compaction



Brookings County Test Sections

Managing Gravel Road Maintenance

Brookings County Sections (con't)

Managing Gravel Road Maintenance

Brookings County modified section used landfill clay mixed on roadway

These things and many more are discussed in the FHWA Gravel Roads Manual. It can be found online by searching for "*FHWA Gravel Roads Manual*"

Managing Gravel Road Maintenance

You may contact me at:

Ken Skorseth
SDSU/SDLTAP
Box 2220-Harding Hall
Brookings, SD 57007-0199

phone 800-422-0129
fax 605-688-5880
email: ken.skorseth@sdstate.edu

Thank You for listening!

Gravel Roads Management Strategies

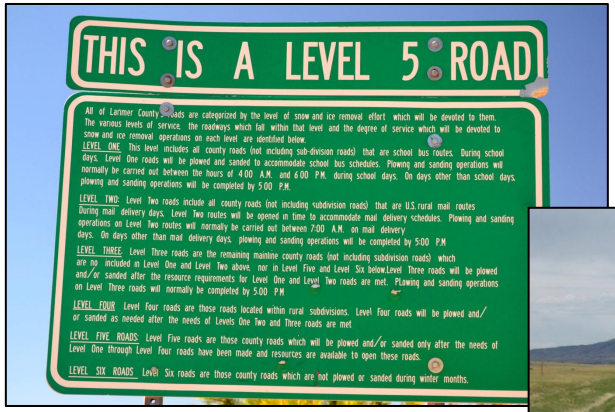
TRB Webinar

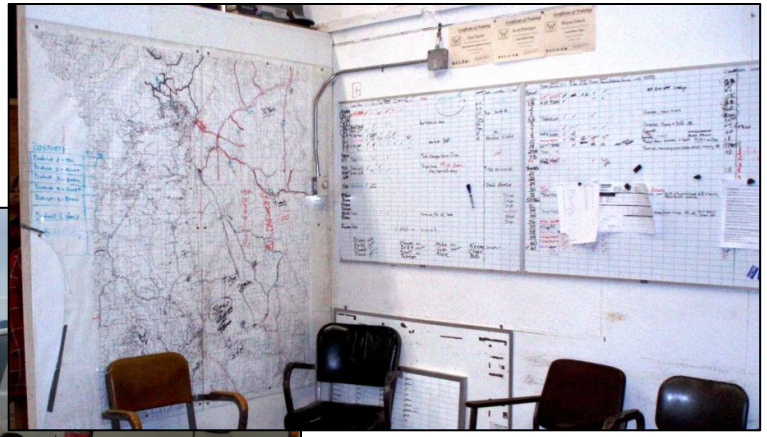
April 10, 2012

George Huntington, PE

Gravel Roads Management Strategies
What we will cover…

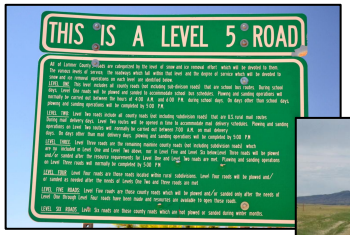
- How are gravel roads managed?
- How should gravel roads be managed?
- How can we improve gravel roads management?





Gravel Roads Management: *State-of-the-Practice*

- Surveys
  - –NACE
  - –ND-LTAP



- Gravel Roads Management Experts' Project
- How are people managing their gravel roads?

Surveys

- ND-LTAP Survey
  - 120 responses
    - MT, ND, SD, WY in 2009
  - Barriers to Roadway Surface Management
    - 87%: Software
    - 64%: Data Collection
    - 52%: Lack of Staff
- NACE Survey
  - 18 responses
    - Annual Meeting in Fort Worth, Texas, April 2010
  - Results in following slides

NACE Survey Results
Condition Data Collection and Storage

- 61% indicated that evaluation of their county's dirt and gravel roads' condition is performed by supervisors and foremen when time allows using a visual rating system and that their results are stored only in their heads.
- 78% do not store dirt and gravel road condition data in a computer.

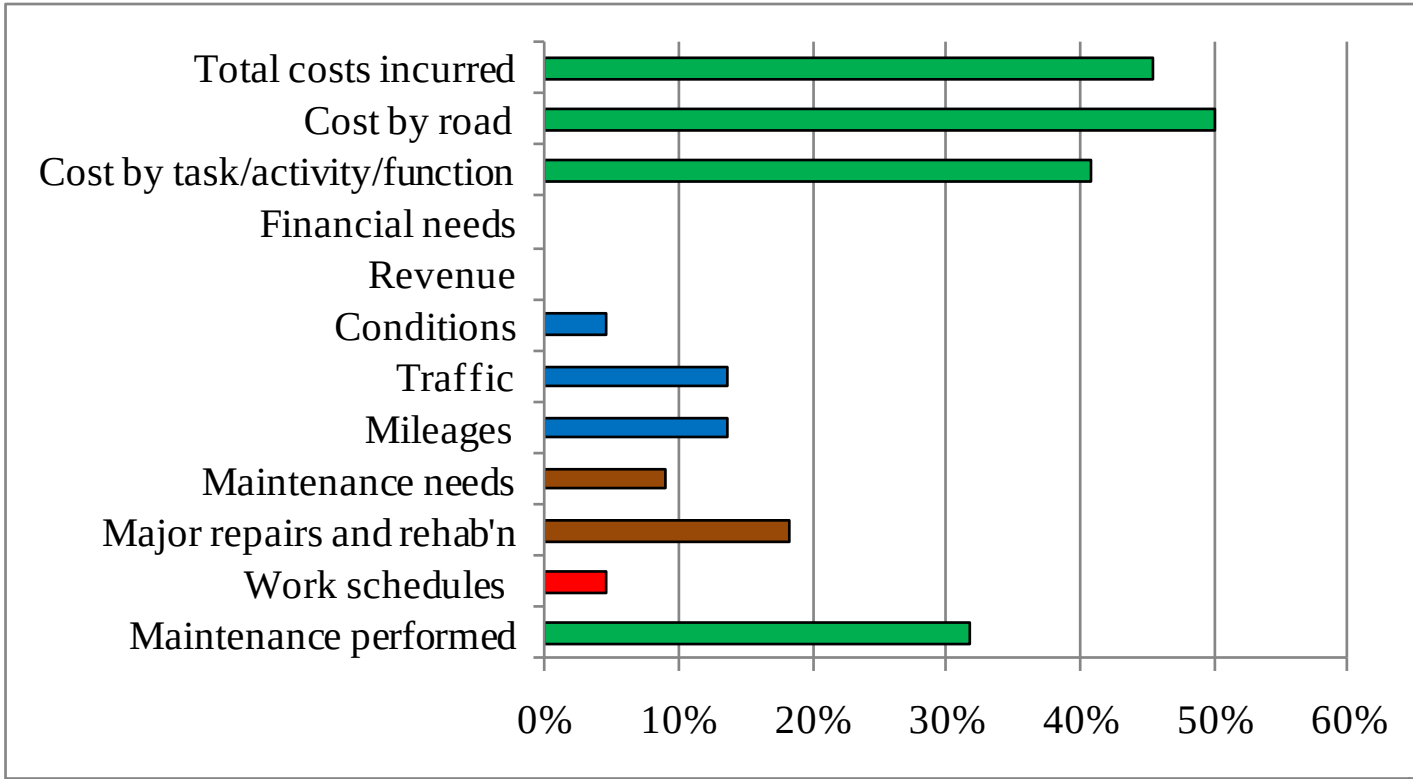
NACE Survey Results
Maintenance Scheduling

- 33% perform routine surface blading on all roads in a district, and then repeat.

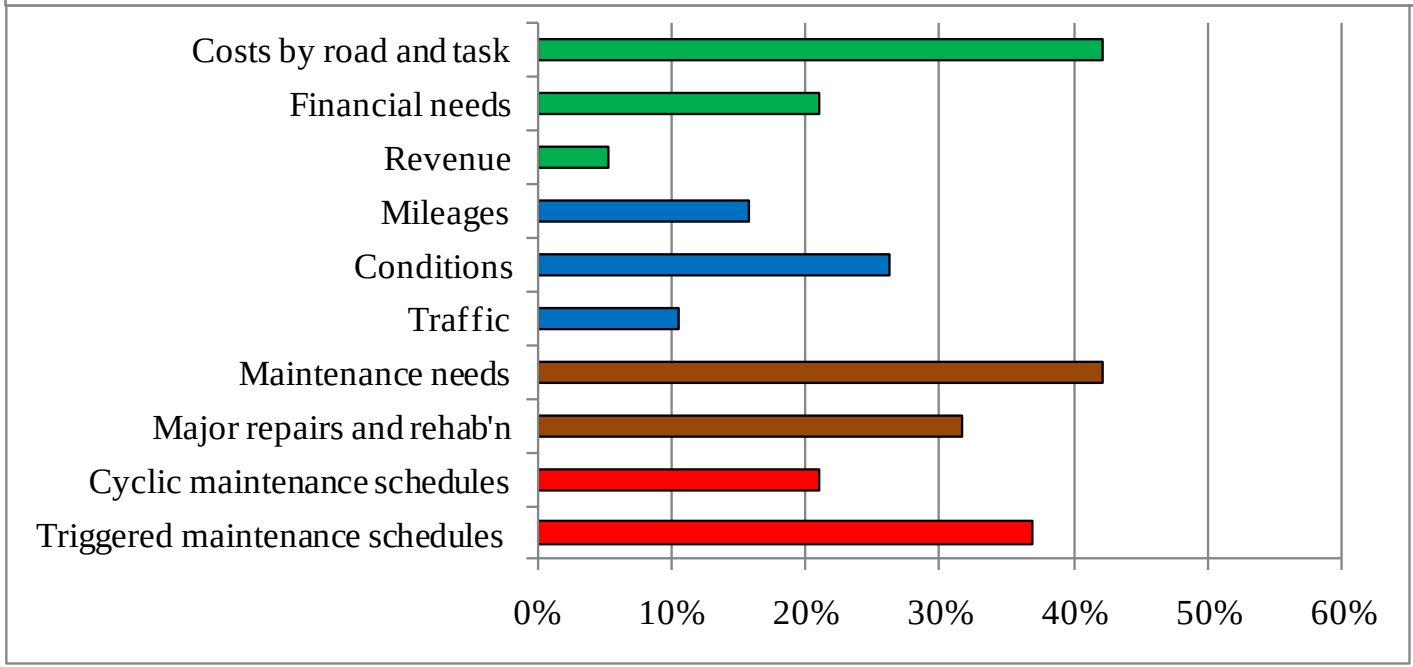
- 83% use neither a formal condition measurement system nor gravel thicknesses to schedule regraveling.

What dirt and gravel roads reports do you generate?

- Financial Data
- Road Characteristics
- Needs Assessments
- Work and Maintenance Plans



What dirt and gravel road reports are or would be particularly useful to you?



Gravel Roads Management Experts' Project
Why and how it happened…

- Based on conversations at TRB 2009
  - Lack of a gravel roads management process for local governments
  - Support from other LTAPs and WYDOT
- Emails, meetings and conversations
  - 2009 and 2010

Participants

Organization/Affiliation	Experts Solicited	emailed comments	Attended Pittsburgh meeting	Participated in Webinar	Attended Rapid City meeting	Attended Washington meeting	TOTAL INPUTS
Counties	24	6	0	1	5	1	13
Municipalities	4	1	0	0	0	0	1
State DOT	5	2	0	2	0	1	5
FHWA	4	2	0	0	0	0	2
USDA Forest Service	5	2	0	0	0	3	5
Other Federal	5	1	0	0	0	0	1
LTAP/TTAP	19	4	10	6	4	7	31
Academia	8	4	1	1	0	2	8
Other Public	4	4	3	1	0	1	9
Private Software Providers	5	0	0	2	2	0	4
TOTAL	83	26	14	13	11	15	79

Objectives

- Minimal effort and cost
- Simple method
- Applicable results
- Save the agency money
- Reduce user costs
- *Operational efficiency*
- *Improved communications*

“I’m not sure if I should applaud the effort or question the merit of the gravel roads management methodology…”

- Dave Kieper, Park County, Wyoming

“Geez you want to take on a lion don’t ya! But hey we need to start and improve on what we are doing with aggregate surfaced roads.”

- Pete Bolander, USDA Forest Service

"…while you might think a gravel road is a gravel road, not all things are equal. The reason a gravel road is in such lousy condition in Wyoming, is probably not the same reason it is lousy in California or in Florida. I would even say that sound knowledge of gravel road maintenance is not universal, but maybe the lack of sound knowledge is."

-Gene Calvert, Collier County, Florida
(formerly Mendocino County, California and Wyoming LTAP)

Group of Experts
What we learned…

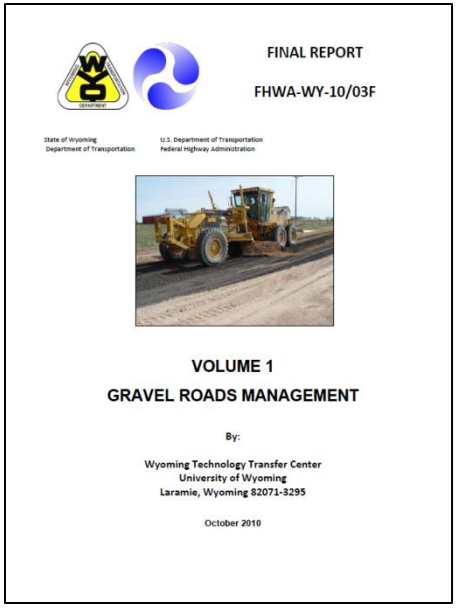
- Little consideration of user costs
- Little gravel roads' performance data
- Limited use of cost data
  - Use of accounting line items, not road items
- Measuring conditions is difficult but not impossible
  - Visual ratings
    - Timing
    - 'Typical' conditions
  - Automated systems
  - Gravel thickness

Products

- Final Report
- Programming Guide
- Implementation Guide
- *Reports and Guides currently available on the Wyoming Technology Transfer Center website*
  - *Click on **'Special Projects'***

Final Report

- Literature Review and State-of-the-Practice
- Methodology
- Implementation
- Analytical Methods
- Summary and Conclusions
- Recommendations
- Appendixes



Programming Guide

- General advice for data managers and programmers
- Detailed lists of fields in a database
- Process flowcharts

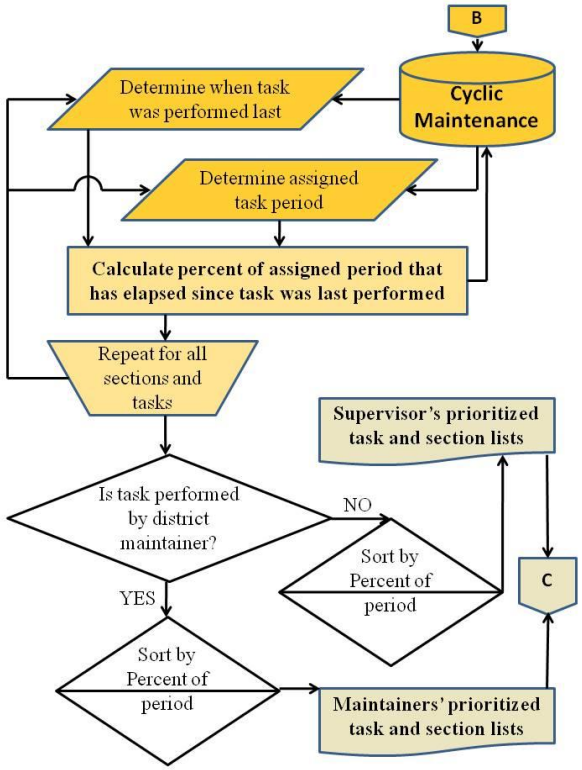


Figure 8 Develop prioritized section maintenance task lists

MNT_TYPE	GRVL_SRC	GRVL_TYP	TRTM_PRD	TRTM_MTD
1 - Blading	0 - Unknown/ Other	0 - Other/ Unknown	1 - CaCl flakes	1 - Topical spray
2 - Reshaping	1 - This Pit	1 - Base	2 - MgCl brine	2 - Motor grader blended
3 - Regravel	2 - That Quarry	2 - Surfacing		3 - Reclaimer blended
4 - Dust Control		3 - Subbase		
5 - Stabilization		4 - Chips		
6 - Isolated Repairs				
7 - Major Work				
8 - Drainage Maintenance				
9 - Other*				

* May want to include lists for maintenance of, for example, signs, culverts, asphalt roads and so on

Implementation Guide

- Assessment
- Data Management
- Inventory
- Maintenance and Cost Tracking
- Condition Data & Performance Monitoring
  - ‘Typical’ conditions
  - During routine maintenance
- Maintenance scheduling
- Network-level outputs

Gravel Roads Management

Key Points

- Sustainability
  - Simplicity
- Primary Outcomes
  - Operational efficiency
  - Communications with public and officials
- Primary Obstacles
  - Performance measurement
    - Rapidly changing conditions
  - Cost and maintenance tracking
    - Inventory and roadway segments

Why manage gravel roads?

- Operational efficiency
  - Routine maintenance frequency
  - Regravel frequency and timing
  - Consider agency and user costs
  - Examples:
    - Will long-term performance and maintenance be better served with 3” of crushed gravel or 6” of pit run aggregate?
    - How much are maintenance costs reduced by various dust control agents?
    - Are our culverts adequately maintained?
- Communicating needs to elected officials and the public

Why change how we manage gravel roads now?

- Maintenance costs are increasing
  - Fuel
  - Materials
  - Labor
  - Equipment

- Budgets are steady or shrinking
- Information costs are decreasing
  - Easier and more efficient information management

Issues and Problems with GRM

- Computers
  - Availability and expertise
- Performance assessment
  - How to measure ‘conditions’
- Operational efficiency
  - Maintenance schedules
  - Economics of gravel types and thicknesses
  - Economics of dust suppression and soil stabilization
- Tightening budgets
  - Justification to elected officials and the public

GRM Strategies and Solutions

- Maintenance Policies
  - Service Levels
  - Functional/Maintenance Classes (AASHTO)
- Cyclic and Triggered Maintenance
  - Work Schedules
- Needs Assessments
- Performance Prediction

- ***Condition Monitoring***
- ***Cost and Maintenance Tracking***
  - ***Maintenance Segments***

Maintenance Policies

- Snow plowing policies as a starting point

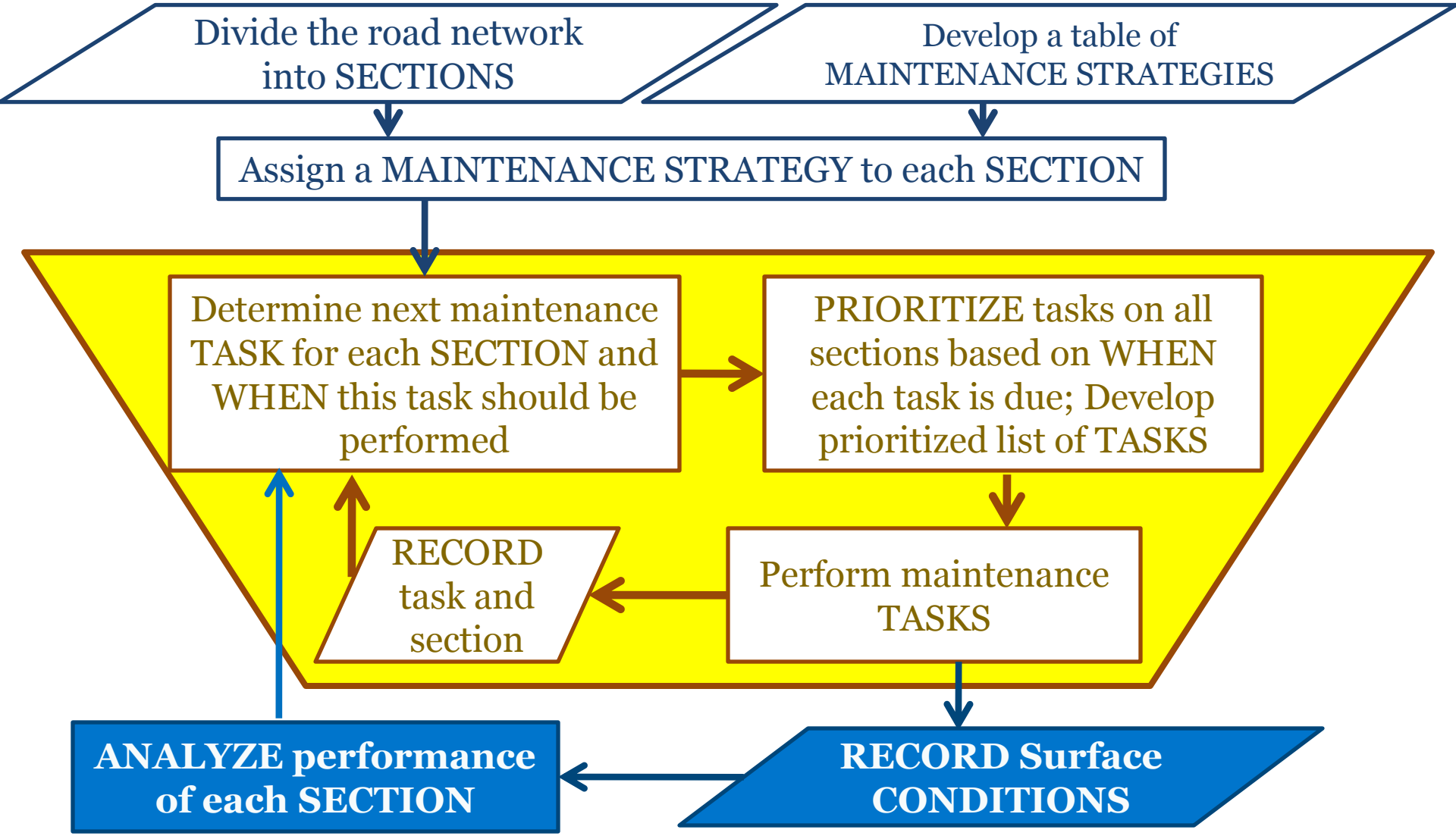
Maintenance Policies

- Expand beyond plowing policies to overall quality and level of maintenance, like Pitkin County (Aspen), Colorado
  - High, Moderate, Low and Limited service roads
  - Roads listed by class
  - Addresses various elements, such as…
    - Plowing
    - Grading
    - Mowing
    - Herbicides
    - Dust control
    - Cross drainage
    - Side drainage
    - Signage
    - Tree/shrub trimming and removal
    - Side slopes
    - Road surfacing
    - Parking areas

Maintenance Scheduling

- Cyclic
  - On a set schedule
  - Maintainers patrol their route, maintaining each road in its turn, on their schedule
- Triggered
  - In response to observed conditions
    - As reported to the agency
    - As maintainers observe roadway conditions
- *Most agencies and maintainers use a hybrid of these approaches.*

Cyclic Maintenance Scheduling



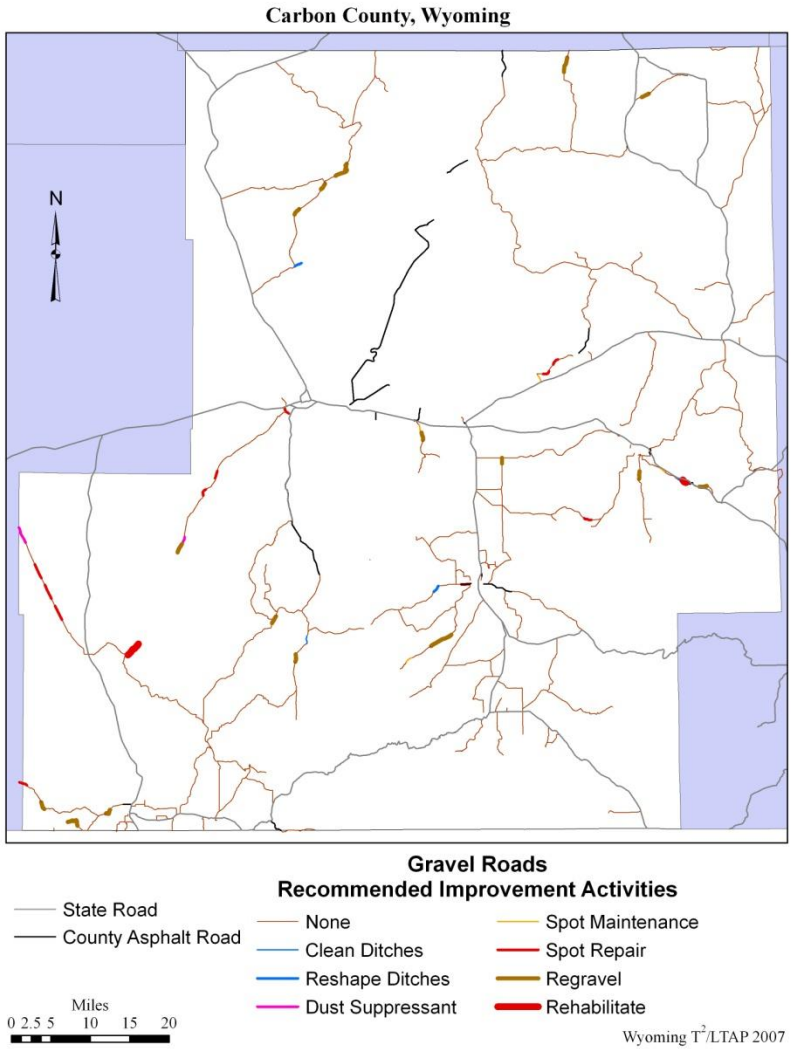
Triggered Maintenance Scheduling

- Set thresholds for maintenance
  - Canadian logging operations
  - Gravel thicknesses
- Complaints
- ‘Check Roads’
- Maintainers’ observations

Network Level Outputs

- Conditions
  - Monitoring
  - Prediction
- Financial tables
  - Needs
- Road tables and maps

	Costs			Miles		
Functional Class	Carbon	Johnson	Sheridan	CB	JO	SH
Resource	$108,661	$0	$108,165	11.7	0.0	12.8
Local	$163,974	$246,607	$468,961	9.5	4.8	7.7
Minor Collector	$681,876	$518,594	$1,545,278	10.5	35.5	39.5
Major Collector	$959,163	$612,917	$1,363,510	17.1	34.0	20.6
TOTAL	$1,913,675	$1,378,118	$3,485,914	48.9	74.3	80.7
Task	Carbon	Johnson	Sheridan	CB	JO	SH
Maintaining	$0	$0	$0	0.0	0.0	0.0
Spot Maintenance	$5,225	$3,440	$4,930	3.9	2.5	3.7
Dust Suppressant	$24,947	$254,584	$53,081	3.1	32.2	7.6
Regravel	$261,149	$364,311	$455,536	21.5	24.6	32.6
Spot Repair	$1,167,845	$531,903	$1,815,233	13.9	6.4	24.8
Rehabilitate	$444,328	$214,842	$1,147,747	2.6	1.4	6.4
Reconstruct	$0	$0	$0	0.0	0.0	0.0
Clean Ditches	$480	$2,523	$1,070	1.0	5.0	2.1
Reshape Ditches	$9,700	$6,516	$8,318	2.9	2.0	3.4
TOTAL	$1,913,675	$1,378,118	$3,485,914	48.9	74.3	80.7



Gravel Roads Management: *Strategies to Tactics*

Strategies: *Maintenance policies, maintenance scheduling, network-level planning*

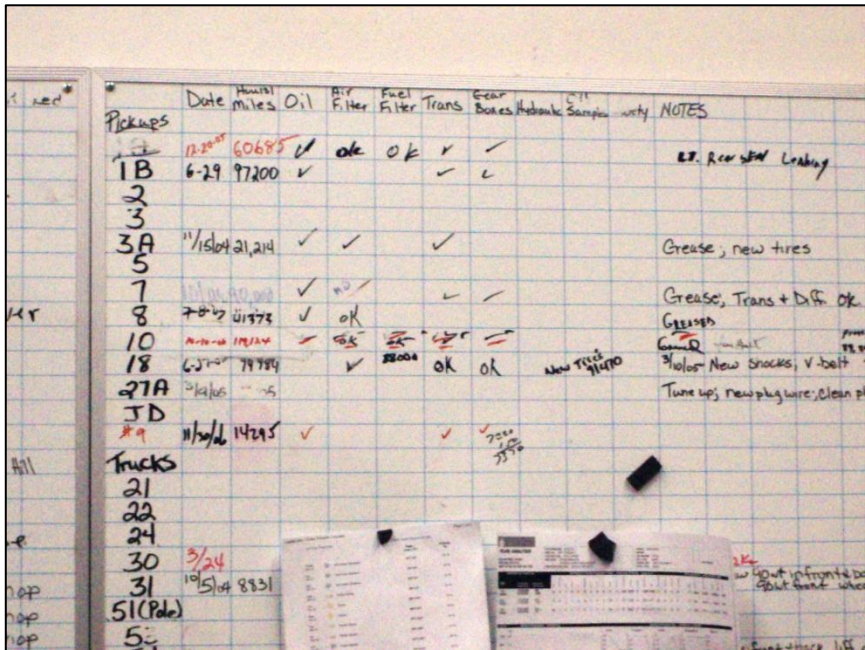
- Agency Assessment
  - Current information management
  - Inventory
  - What tools do we have?
  - What methods might we implement?
  - What obstacles must we overcome?

Management Methods

- Maintenance and Construction Policies
  - Snow removal
  - Surface type
  - Maintenance frequency
  - Other activities and features
- Conditions
  - Past, Present and Future
- Historical Costs
- Maintenance History
  - Inventory and Segmentation

Management Tools

- Inventory
  - Segmentation
- Field Data
  - Time cards, work orders, equipment logs
  - Maintenance performed
- Condition Data
  - Asphalt: Yes..?
  - Gravel: No..?
- Cost Data
- Analysis
  - Spreadsheet models
- Reports



Obstacles

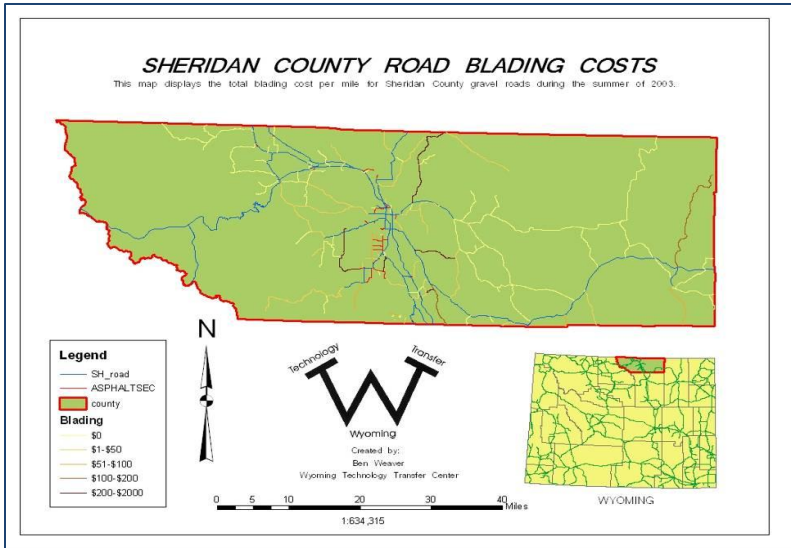
- Software
  - Capable administrator
- Analytical Goals
- Data Collection
  - Inventory
  - Performance/Condition
- Maintenance and Cost Tracking
  - Inventory
- ***Time and Money!!!***

Assessment:
What improvements are needed?

- How are *cost data* tracked, stored, analyzed, used and presented?
- How are network *conditions assessed*, used, recorded and presented?
- How are maintenance *strategies established* for each road section?
- Is the unsealed road network *managed* as *efficiently* as practical? Can this be *documented*?
- Is *information provided* to the public and to elected officials that let them *understand road and street management* well enough to make good decisions regarding funding and other higher level management decisions?

Assessment:
What have you got?

- Political and Professional Support
- Financial Resources
- Information
- Hardware, Software, GPS & GIS
- *Personnel*
  - ***–Succession!!!***



Inventory

Maintenance Management Segments

- Segment ID
- Location
  - Road
  - Begin
  - End
- Surface Type
- Length
- *Lots of others*

Data Management

- Types
  - Manual
  - Spreadsheet & Database
  - Geographic Information System (GIS)
- Sources
  - Commercial package
  - Free package
  - In-House

Condition Data and Performance Monitoring

- Visual 'windshield' survey: PASER; WY-LTAP
  - Quick
  - Training
- Deduct value method: USACE URCI
  - Distress extent and severity
  - Time consuming
- Automated systems
  - Becoming easier
- Gravel thickness
  - Excavation
  - GPR

Surface Condition Evaluation

Problems

- Rapidly changing conditions
  - Weather
  - Maintenance
  - Traffic
- Subjective 'windshield' rating methods
- Automated systems
  - Varied vehicle paths
  - Timing

Solutions

- Ride Quality Rating Guide
  - Wyoming LTAP website
- Evaluate under 'typical' conditions.
  - At least several weeks after surface maintenance.
  - Don't evaluate right after a heavy precipitation event or spring thaw.
- Evaluate by operator immediately before maintenance.

Maintenance and Cost Tracking

- Line items and the ‘accountants’ issue
  - Maintenance tasks
- Is information telling you all it could?

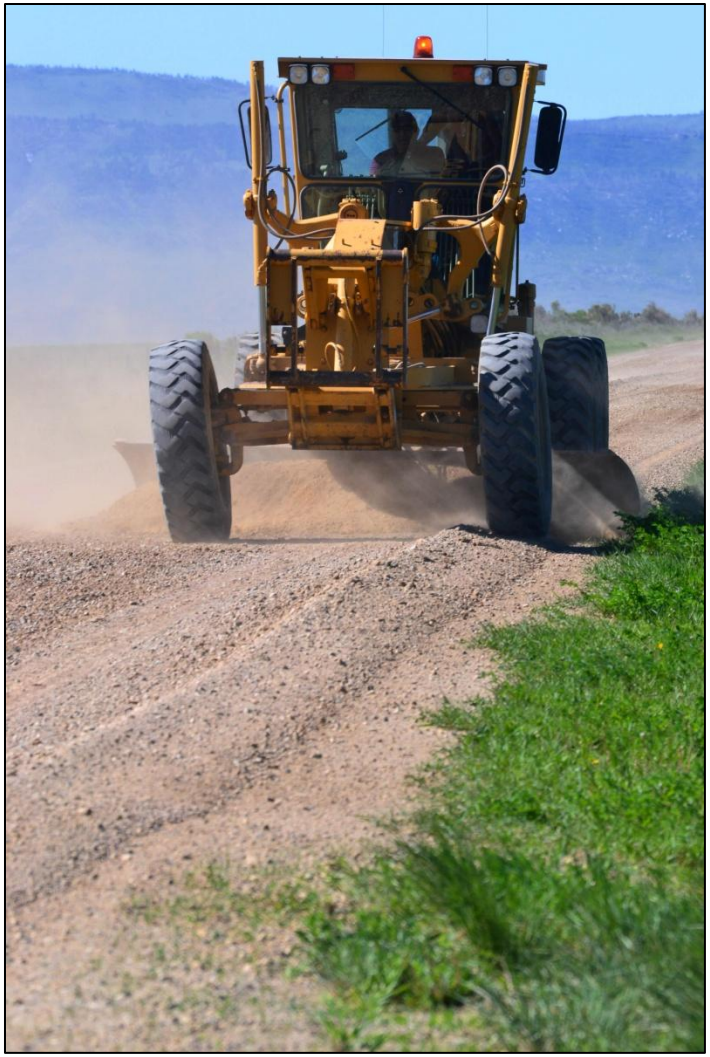
When deciding how to maintain your roads, do you care…

Whether gravel is hauled by your trucks or by a contractor's trucks?

Whether the gravel fixed soft spots or regraveled a whole section?

Eight Maintenance Tasks

- Blading
- Reshaping
- Regravel
- Dust Control
- Stabilization
- Isolated Repairs
- Major Work
- Drainage Maintenance



Closing Thoughts…

- Common problems…
  - Inventory not properly segmented
  - Maintenance line items
  - Lack of performance evaluation records
- Simple solutions…
  - Good, segmented inventory
  - Visual condition rating
  - Maintenance policies
  - Maintenance schedules
- Ultimate goals…
  - More efficient operations
  - Better communications

How do we save money?

- Don't over-maintain
  - Very low-volume roads
    - Consider user costs
  - Do the washboards come right back?
- Haul higher quality gravel when cost-effective
  - Save blading costs
  - Reduce dust
  - Reduce regraveling frequency
- Use dust suppressants and soil stabilizers when cost-effective

Gravel Roads Management: *Summary*

- Computer expertise is opening up options
- Inventory
  - Segmentation
- Condition and performance measurement needs to be well timed, and it is important
- Maintenance policies
- Maintenance scheduling and cost tracking
- ***Goals*: Efficiency and Communication**

Gravel Roads Management Strategies

Questions? Comments? Advice?

George Huntington, PE