1 **Gravel Road Maintenance for Townships**
MN LTAP

2 **Workshop Goals**

- Share information
- Discuss: how to deliver service?
- Review policies around gravel road
- Share "best practices"
- Improve service by knowledge-sharing
- Renew your knowledge about "what is good gravel"
- Leave the workshop today with new ideas on how you can improve gravel road maintenance
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3 **Introduction**

Gravel roads are experiencing changes:

- Type of traffic
- Size
- Horsepower

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The effect of those changes is

- not understood by passenger vehicle users
- a need for stronger bases and surface
- the need for better drainage

4 **Introduction**

Gravel road quality depends on:

- The proper use of a motor grader (or other grading device)
- The quality and volume of good surface gravel

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5 **Section 1: Gravel Road Basics**

5 out of every 10 roads (50%) in United States are unpaved

6 **Gravel roads tend to encounter the following road management problems:**

1 • Drainage/loss of grade line
- Road defects such as wash boarding, potholes and ruts
- Gravel availability
- Erosion

- Intrusive roadside vegetation
- Dust control
- Reshaping
-

2
- Resurfacing
- Reconstruction
- Operator training
- Taxpayer complaints
- Liability (risk of lawsuits)
- Rising costs of:
  - Gravel
  - Dust abatement products
  - Base stabilization products
  - Equipment & personnel
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8 **Maintenance**

Typical maintenance includes:

1. Blading to maintain crown.

2. Adding surface gravel as needed either by “spot graveling” or placing fresh gravel on an entire section.

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9

This gravel road is in great shape.

10 **Typical maintenance**

Maintenance differs from paved roads because it is needed much more often on gravel roads, and the surface conditions are much more dependent on weather and traffic.

11 **Gravel road distresses**

- Improper cross section
- Inadequate roadside drainage
- Corrugations or wash boarding
- Vegetation encroachment

12 **Ponding**

- Ponding water or evidence of ponding water on the road surface; or
- The road surface is completely flat (no cross-slope)
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13 **Inadequate Roadside Drainage**

Poor drainage causes ponding. Drainage becomes a problem when ditches and culverts are not in good enough condition to direct and carry runoff water because of improper shaping.

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14 **Winter Damage**

1. Snowplowing gravel loss
2. Traffic damage
3. Winter freeze and thaw cycles

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15 **Corrugation or washboarding**

Closely spaced ridges and valleys (ripples) perpendicular to traffic and located at regular intervals. Usually caused by traffic loading and loose aggregate, and located on hills or curves, in areas of acceleration or deceleration, or in areas where the road is soft or potholed.

16 **Dust**

Caused by wear of traffic on gravel roads that loosens the larger particles from the soil binder.

Dust is an environmental problem and contributes to many complaints from adjacent property owners.

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17 **Potholes**

Depressions in the road surface, usually less than 3 feet in diameter.

Produced when traffic wears away small pieces of the road surface at soft spots in the underlying soils.

They grow faster when water collects inside the hole.

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18 **Ruts**

Surface depression in the wheel path parallel to the road centerline.

Caused by a permanent deformation in any of the road layers or sub grade.

Result from repeated vehicle passes, especially when the road is “soft”.

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19 **Loose Aggregate**

The wear and tear of traffic on gravel roads will eventually loosen the larger aggregate particles from the soil binder, leading to loose aggregate particles on the road surface or shoulder.

Traffic moves loose aggregate away from the normal road wheel path and forms berms in the center or along the shoulder or in less traveled areas.

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20 **Section 2: Promoting Good Drainage**

21 **Drainage**

- Get the water OFF the road (maintain crown)
- Keep the water OUT of the road (adequate ditch depth, smooth surface)
- Keep the water AWAY from the road (clean ditches, adequate approach, install centerline culverts)

22 **How a gravel road stays drained:**

23 **Cross Section Elements**

24

25

26 **Section 3: Adding Gravel and Shaping**

27 **Prepare Surface**

Remove all washboarding, potholes and restore a uniform crown.

28 **Maintaining Gravel Quality: Start with the Stockpile**

Blend material prior to loading to eliminate segregation in the stockpile.

29

30 **Hauling and Spreading**

- Install warning signs according to MMUTCD.
- Calculate the spread for each load.
- Spread as evenly as possible.
- Equalize the material by building a uniform windrow.
- Spread the material from the windrow.

31 **Determining Aggregate Quantities**

32 **Gravel Spreading Example**

What is the required spread for a 10 cubic yard load in order to place 2 inches of new gravel on a 24-foot wide road?

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34

35 **Gravel Spreading Example**

What is the required spread for a 10 cubic yard load in order to place 2 inches of new gravel on a 24-foot wide road?

36 **Gravel Spreading Chart**
In Feet per Truckload

For a 10 cubic yard truck, spreading at 800 cubic yards/mile, determine the spread length?

37

38 **Gravel Spreading Chart**
In Feet per Truckload

For a 10 cubic yard truck, spreading at 800 cubic yards/mile, determine the spread length?

To convert from cubic yards to tons in loose volume (LV)

- Multiply cubic yards by 1.4
- 800 cubic yards x 1.4 = 1,120 tons
- Convert tons to cubic yards by dividing by 1.4

- To convert to compact volume (CV), divide cubic yards by 1.8

Section 4: Knowing Good Gravel

What we want from a gravel surface:

- Doesn't corrugate or washboard
- Is not greasy when wet
- Is not dusty when dry
- Never potholes
- No loose rocks on the surface
- No ruts in the wheel tracks

What we get from some gravel sources? none of the above
Why? COSTS

Every road agency must balance the amount of funds available for gravel surface, how much gravel material is needed, and the cost of available gravel material.

Gravel Costs

1. <u>If your budget is $20,000, then you can haul:</u>

   Screened:$20,000/$6.50 = 3,076 CY
   Crushed: $20,000/$9.50 = 2,105 CY
   Note: this is 971 CY less than screened material
   Screened material should still be tested to see size of rock, stone, sand and binder.
2. <u>Rule of thumb for relative value of gravel surfacing:</u>
   Crushed: 1.0 Best
   Screened: 0.67 Lesser Value
   Pit-Run: 0.50 or less if size is under 1"

1 If we applied these factors to the example:

3,076 cy screened (use a factor of 0.67) is equivalent to 3,076 x 0.67 = 2,060 cy crushed

2,105 cy crushed (use a factor of 1.0) is equivalent to
2,105 x 1.0 = 2,105 cy crushed

2 Therefore, in this example, crushed gravel would be the best value for the budget for a quality road surface material.

48 **Reasons Why Crushed Gravel is Better than Screened or Pit-Run**

- Aggregate size is more uniform.
- Greater aggregate loss when blading screened or pit-run material so gravel doesn't stay on the road as long.
- With screened gravel and especially pit-run, the top size material will be much larger and the spread may be shorter, or the aggregate will be lost.
- Crushed gravel should compact better and form a more stable crust that resists aggregate loss.

49 **Recipe for Gravel**

1
- Gravel is not just a bunch of rocks!
- It is a uniform mixture of stones, sand, and clay that, when compacted with adequate moisture, will form a hard crust on the road.

2 Basic Recipe:
25% medium stones, 3/8" to ¾"
20 % smaller stones, less than 3/8"
35 % coarse to medium sand
20 % very fine sand to clay

50 **Recipe for Gravel**

The shape of the stones and sand particles is also very important. Sharp, angular particles will compact better and stay on the road longer than rounded, smooth particles.

51

- Crushing of the pit-run gravel dramatically improves the quality.
-
- Too too much sand and not enough binder (clay) is a problem. Sandy gravel will not set up, corrugates easily, and leaves a lot of loose aggregate (float) on the road surface. Slow rains will soak through the gravel, saturate the road subgrade, and make the road soft.
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- Too much binder (clay) creates a sloppy and slippery surface when it rains.

52

- Gravel with too much binder is like concrete when it's dry. However, this type of road can also get very dusty.
- This problem will eventually solve itself when all the binder blows away over time.
- Use a higher percentage of binder on gravel over sandy soils and a lower percentage over clay soils.

53 **Sources of Good Gravel**

- Most county highway departments get bids for gravel crushing, and have the necessary testing equipment and trained personnel to monitor the crushing operation to ensure quality.
- A township or city may be able to work with the county highway department to piggy-back their gravel needs and requirements with the county contracts.
- Talk with your county engineers and discuss how to best combine your gravel needs with the county.
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54 **Sources of Good Gravel**

- Maintain a separate stockpile in a pit and modify your specifications to fit your needs, which may allow for savings on mobilization and testing costs.
- Including your gravel needs with the county's needs makes the size of the overall contract larger and more attractive to contractors, resulting in a lower cost/cubic yard.

55 **Sources of Good Gravel**

- To reduce the initial capital investment in a pile of gravel, make arrangements with the county to buy what you need each year from their pit. Coordinate and provide advance notice of your approximate annual needs.
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- Crushing is usually not cost-effective unless the pile is 10,000 cubic yards or more; the bigger the pile, the cheaper the price per cubic yard.

56 **Finding new sources of gravel**

Conduct research in your area for potential gravel sources:

- Hire someone with a small backhoe to dig test holes in potential areas. When you find a source, try to buy the land or enter into a long-term lease with the owner.

57 **Recycled Materials**

- Using recycled concrete and asphalt materials is now common. These can be crushed or pulverized and made into good gravel or added to "sweeten" poor quality raw gravel.
- Recycled glass can be added during the crushing process and may improve the gravel while recycling a product.
- Asphalt shingles are also sometimes used as an additive in gravel road mixtures, 25-

50% mix works well.

58 **Gradation Exercise**

In this exercise, we will:

- Define what a gravel gradation is
- Understand how a gradation can help us to determine if we have "good" gravel or not
- Learn to read a sieve analysis

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61 **To Do List**
(when you get back to the office/shop)

1. Inventory: assess your gravel sources
2. Investigate: check out sources and costs of crushed gravel
3. Review: look at the gravel's typical gradations
4. Organize: cooperative purchasing and/or processing of gravel materials between your county, area cities, and townships
5. Develop: a re-graveling program and budget
6. Develop: policies to "save" the gravel
7. Locate: new gravel sources

62 **Section 5: Turning a Poor Gravel Road into a Good One**

63 **7 Crucial Factors to building and Maintaining a Great Gravel Road**

64 **Understand Your Needs**

- Before construction or rebuilding begins, it is necessary to understand the needs and uses of the area where the road is located.
- Is the traffic heavy industrial, farming or residential?

65 **Build on a Strong Foundation**

- A strong foundation is essential in any construction project.
- Ideally you will build your road on a strong, deep subgrade.
- There are times, however wet soils and weak soils where we need to sub cut and use select backfill materials and engineering fabric.

66 **Choose the Right Materials**

- The best materials for a project are typically determined by the location of the project.
- Depending on the areas available resources ideal aggregate will very, but all should drain well. It is important to select the proper gravel for its respective use as either surface or base material.

67 **Build from the Bottom Up**

- In the same way choosing the right materials is crucial, the order in which they are applied and how can be the difference between a great cost-effective gravel road and a weak one that needs constant expensive repairs.

68 **Again: Drainage, Drainage, Drainage**

- In many ways, all the most important steps of gravel road maintenance and construction are related to drainage.
- Roads that allow water to properly drain off the surface and out of the roadbed soils are much easier to maintain and therefore less costly.

69 **Apply Proper Palliatives (Stabilizing Agents)**

- Once the road is near completion, we can stabilize it with material to help bind the aggregates together, serving as both a strengthening and protecting agent.
- This added agent will help to strengthen for the ever-increasing equipment, in both size and horsepower, resulting in increased tire pressures and greater damage.
- We are seeing more and more economical base stabilization being used throughout Minnesota.
- Dust control can add a benefit also.

70 **Maintenance**

- Whether accomplished through regular grading or soil stabilization, keeping a regular and thorough maintenance schedule will ensure the road performs well. Correct technique is essential and best left to the experienced grader operator.
- Surfacing materials must be recovered periodically and/or replaced in thin and worn out places.

71 **Basic Elements**

The three most important factors in a good gravel road are: Drainage! Drainage! Drainage!

1. Drainage: adequate crown on road surface
2. Drainage: eliminate standing water in ditches
3. Drainage: adequate approach and centerline culverts

* Eliminate as much of the subsurface moisture as possible. Too much subsurface moisture is our enemy and has "killed" many a gravel road. It is the cause of frost heaves, soft roadbeds, and frost boils.

72 **Top Ten list for designing a good gravel road**

10. Use an 18" minimum size for centerline culverts.

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Note: this could be a possible stopping point.

74

The Local Road Research Board has developed a guide for Low Volume Aggregate Surfaced Roads (Publication No. 92-01).

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The guide helps you decide how thick your gravel base should be to adequately handle the traffic you expect on a given roadway. Thickness is based on the soil type, traffic counts, and type of gravel base available.

75 **Gravel Thickness Example**

How much surface and base gravel is required for a newly constructed road which has a clay loam sub grade with a soil factor of 100 and two-way traffic of 150 vehicles per day?

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77

78 **Gravel Thickness Example**

How much surface and base gravel is required for a newly constructed road which has a clay loam sub grade with a soil factor of 100 and two-way traffic of 150 vehicles per day?

Class 1 Surface = 4 inches
Class 5 Base = 4 inches

Or, if using screen (but not crushed) Class 3 material instead of Class 5 Base = 5 inches

Or, if using pit-run material instead of Class 5 Base = 8 inches

79 **Structure and Standards continued**

It's important to understand the difference between an ideal situation and reality.

The charts show the ideal thickness of gravel; the reality is that most agencies can't afford to put down this much gravel. So, when your roads fail in the Spring, you will know why.

80 **Section 7: Frost Boils**

81 **Major Causes**

Frost damage or cold weather-related road distress caused by:

- Expansion and heaving of the underlying subgrade materials as they freeze.
- Subsequent saturation and weakening of their load carrying capacity as the road thaws out.

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82 **Major Causes**

Generally, most frost damage areas can be defined by two categories:

- Subgrades with variable compositions of different soils in the subgrade and their capability of drainage of excess moisture and with the presence of ground water.
- Subgrades very close to groundwater. Groundwater is the most critical component of heaving frost susceptible soils when they freeze.
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83 **Frost Boils**

Occur in low subgrade areas when surface drainage and ground water accumulate. Typically found in wetlands areas, swales, ravines and flood plains.

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Repairs should:

1. Improve subgrade uniformity.
2. Reduce or limit the impact of subgrade moisture.

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SOLUTION: Address the causes not the symptoms, evaluate using the available onsite materials and local materials.

84 **Frost Boil Repair**

No repair will be universal

Each site is unique

Suggested treatment:

- Scarify and compact top 6 – 12′″ to blend and dry the materials and compact the area.
- Remove material to a depth of 12 – 24″, mix and dry material, replace and compact. May require addition of select materials.
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85 **Frost Boil Repair**

- Remove poor soils replace with select good materials and excavate to 12 – 24″. Compact new materials to get density.
- New materials can be granular borrow or class 5 aggregate.
- Pay close attention to drainage: get and keep moisture out of the area.
- Construction materials can and should be used to aid in strength and load-bearing capacity. Engineering fabrics, drain tile and grid materials work very well.
- Excavation transition or the taper from the cut on each end should be a min. of 1:5 with max. at 20:1 taper.

Improve subgrade uniformity, limit moisture, strengthen the problem area and replace gravel surface. Done!

86 ☐ **Equipment**

Advertise for quotes based on hourly rates for different types of equipment such as backhoes, dozers, and scrapers, along with an idea of how much work there is to be done.

87 ☐ **Section 8: Establishing a Road Management Program**

88 ☐ **Establishing a Road Management Program**

1. Develop some basic standards:
   *Road dimensions
   *Levels of service
   *Criteria for ranking
2. Inventory your roads, assess their condition, and identify problem areas
3. Select the most appropriate treatment to improve each problem area
4. Estimate the cost of each repair using generalized costs

89 ☐ **Road Management Program**

1. Prioritize improvements based on:
   *Immediate improvement to serviceability
   *Available funding
   *Work that can be done with your own crews and equipment
2. Establish priorities and create a 3-5 year program.
   ** Make sure to include preventive maintenance items such as ditch and culvert cleanout, fix ruts and potholes, etc.
3. Seek approval for an increase in annual funding to accomplish the program.
4. Update your program annually and keep your decision makers informed on the progress being made.

90 ☐ **MN Local Road Research Board Tool**

91 ☐ **To Do List**
(when you get back to the office/shop)

1. Develop: a policy on basic design standards for improvement and levels of service.
2. Coordinate: with adjacent townships, counties or cities to provide similar levels of design and service, based on use. Ask for help on this.
3. Inventory: your roads and develop a prioritized list of improvements with estimated costs. Think about truck routes.
4. Develop: criteria to rank improvements.

5. Establish: a capital improvements budget.

92 **Section 9: Equipment**

The motor grader is the basic and pre-eminent piece of equipment necessary for gravel road maintenance.

93 **Equipment Innovations**

While some may be too costly for one unit of government to purchase, sharing the cost with another agency or leasing from a local contractor or vendor may be an option.

- Windrow pulverizes
- Carbide-tipped bits and cutting edges
- Shouldering disks
- Grader-mounted dozer blade
- Grader-mounted roller

94 **Summary**

Maintenance is also important

- Maintain the road shape
- Use best material as possible
- Handle material carefully to avoid segregation
- Allow for shrinkage during compaction

95 **Thank you!**

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