

Back to the Gravel Basics

10 Year Gravel Research Project (86.12 Miles)

How Nicollet County reduced operating hours by 46% & gravel use by 50%
\$156,000 Annual Savings



Mission Statement

Providing efficient services with innovation and accountability.

Vision Statement

Setting the standard for providing superior and efficient county government services through leadership, accountability and innovation to a growing and diverse society.

**Leadership. Efficiency.
Accountability.
Innovation. Integrity.**

Current Nicollet County Gravel Road

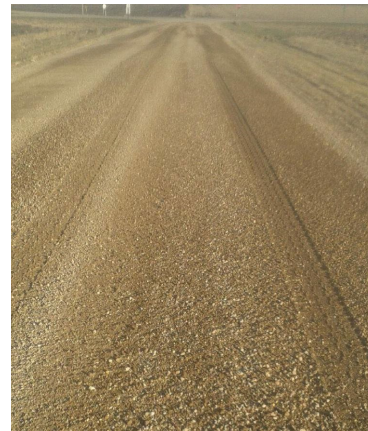


Agenda

1. Previous Issues
2. Research
3. Training
4. Plan Reading
5. Documenting
6. Gravel
7. Gravel Use Formula
8. Operating Standards
9. Reclaimers
10. Packers/Rollers
11. Yearly Maintenance Sequence

Previous Issues

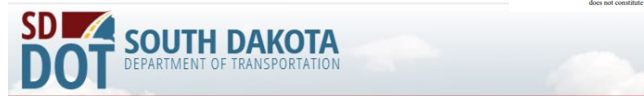
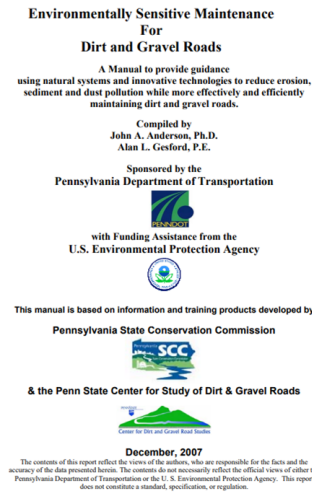
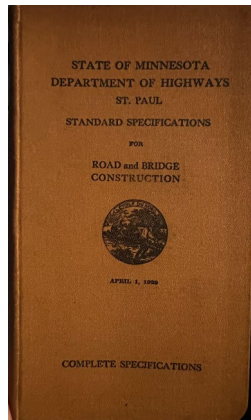
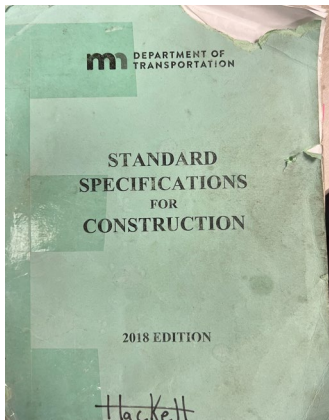
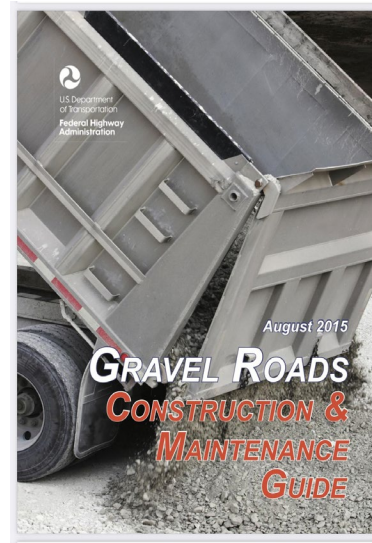
- Office Concerns
 - No
 - Data
 - Standards
 - Training
 - Documenting
 - Facts
 - Time and material?
- Road Concerns
 - Washboards
 - Loose rocks
 - Sod clumps
 - Materials used
 - Shape of road
 - Blade sequences



Research



Center for Transportation Studies
Minnesota Local Technical Assistance Program (LTAP)



MANUALS & DOCUMENTS

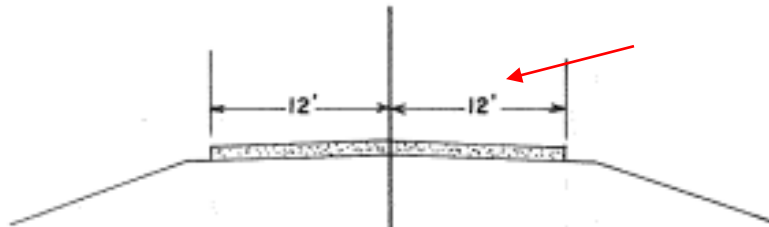
Training

- LTAP operator training
- Yearly blade meeting with operators and other Counties and Townships
- On-line blade videos

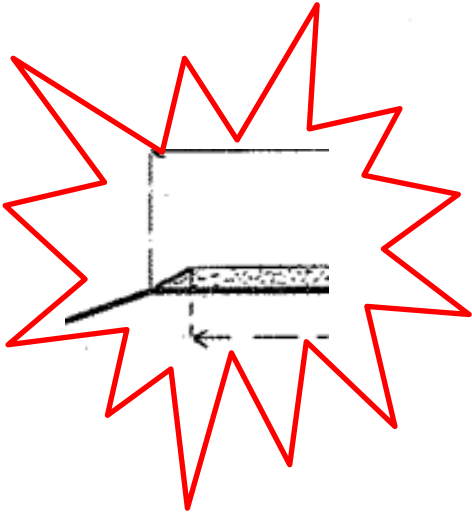


“STICK TO THE PLAN”

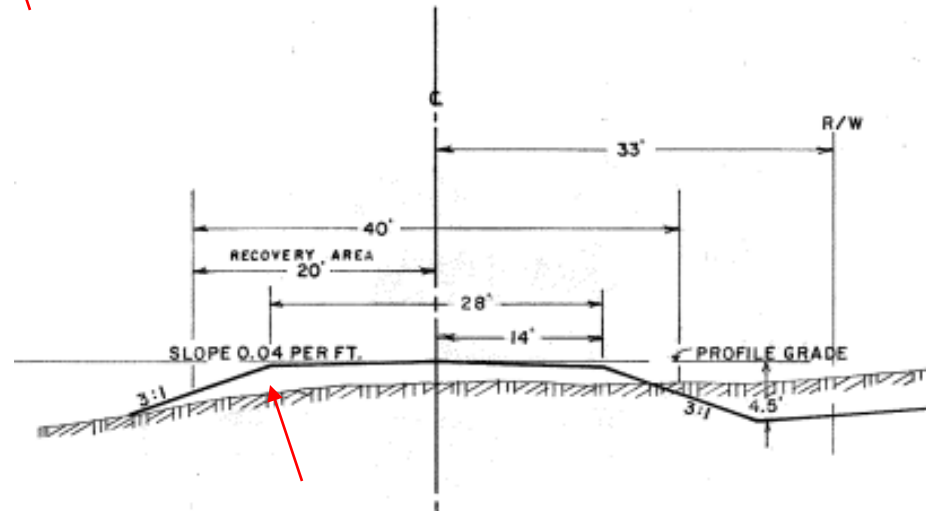
TYPICAL BASE & SURFACE SECTIONS



GRAVEL WEARING COURSE COMPUTED AT THE RATE OF 800 TONS PER MILE DRIVEWAYS NOT INCLUDED. WILL BE WILL DONE BY OTHERS

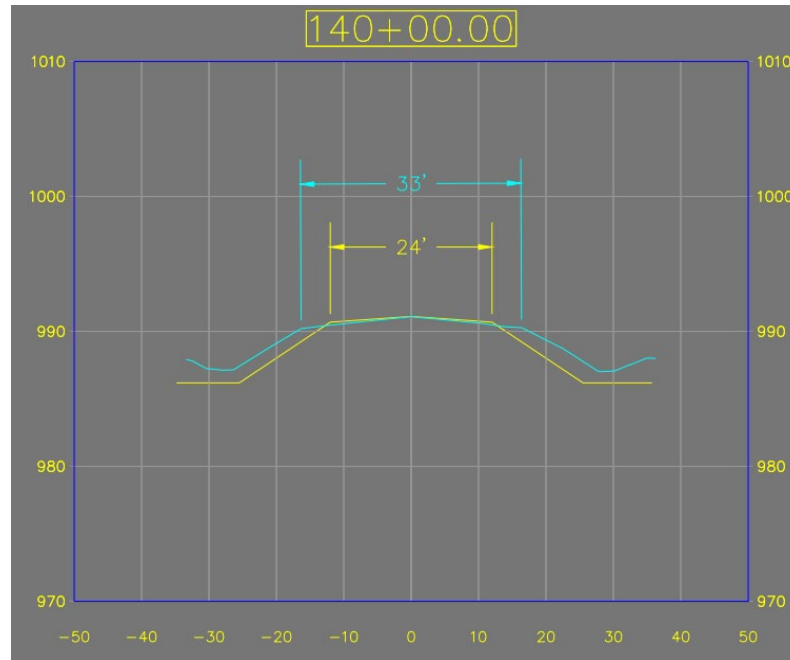


TYPICAL GRADING SECTIONS



Document Road Conditions

- Crown
- In-Slope
- Width
- Gravel Depth
- Weekly Notes



10-24-22
7 small washboards
57 nice
19S small washboards
4 by Krohn small washboards, same
12 weeks now without rain.
10-18-22
Dev- Checked 76 and it's already bad

10-17
No rain since 8-6
7 south small washboards from harv
57 is great, 7 is great



History of NC Gravel

- Nicollet County
 - 1988 – 2008 Class 1A
 - 200:
 - 1988: 8-15% ←
 - 1995: 7-12%
 - 1997: 6-10%
 - 2009: Class 7B
 - 200: 6-10%
 - Bonded together great right away, but eventually dried out and gravel became very loose.



1982

Convert Passing to Retained

Retained Gravel Calculator for Custom Mixes

Custom **Mix Ratio 2** to Current **1**

Notes: Must quantify dry blade window to know how much to spread tons per mile

Enter Data in Yellow Sections

Goal Gravel Mixture

Goal Gravel			
Retained		Passing	
3/8"	12.00%	3/4"	100
No. 4	15.00%	3/8"	88
No. 10	16.00%	No. 4	73
No. 40	36.00%	No. 10	57
200	12.00%	No. 40	21
-200	9.00%	200	9
100.00%			

Current Gravel Mixture

Current Gravel			
Retained		Passing	
3/8"	18.00%	3/4"	100
No. 4	13.00%	3/8"	82
No. 10	9.00%	No. 4	69
No. 40	45.00%	No. 10	60
200	10.00%	No. 40	15
-200	5.00%	200	5
100.00%			

Custom Mix for Goal Gravel

Custom Mix			
Retained		Passing	
3/8"	9.00%	3/4"	100.00
No. 4	16.00%	3/8"	91.00
No. 10	13.50%	No. 4	75.00
No. 40	31.50%	No. 10	55.50
200	13.00%	No. 40	24.00
-200	11.00%	200	11.00
100.00%			



Retained Gravel Calculator for Blend Mixes

Gravel **Mix Ratio 3** to Gravel **1**

Notes: Must quantify dry blade window to know how much to spread tons per mile

Enter Data in Yellow Sections

Gravel #1 Mixture

Gravel #1			
Retained		Passing	
3/8"	18.00%	3/4"	100
No. 4	13.00%	3/8"	82
No. 10	9.00%	No. 4	69
No. 40	45.00%	No. 10	60
200	10.00%	No. 40	15
-200	5.00%	200	5
100.00%			

Gravel #2 Mixture

Gravel #2			
Retained		Passing	
3/8"	12.00%	3/4"	100
No. 4	15.00%	3/8"	88
No. 10	16.00%	No. 4	73
No. 40	36.00%	No. 10	57
200	12.00%	No. 40	21
-200	9.00%	200	9
100.00%			

Results from Gravel #1 & #2

Blend Calculation			
Retained		Passing	
3/8"	16.50%	3/4"	100.00
No. 4	13.50%	3/8"	83.50
No. 10	10.75%	No. 4	70.00
No. 40	42.75%	No. 10	59.25
200	10.50%	No. 40	16.50
-200	6.00%	200	6.00
100.00%			

History of Nicollet County Gravel

1988 Nicollet Class 1 Gravel



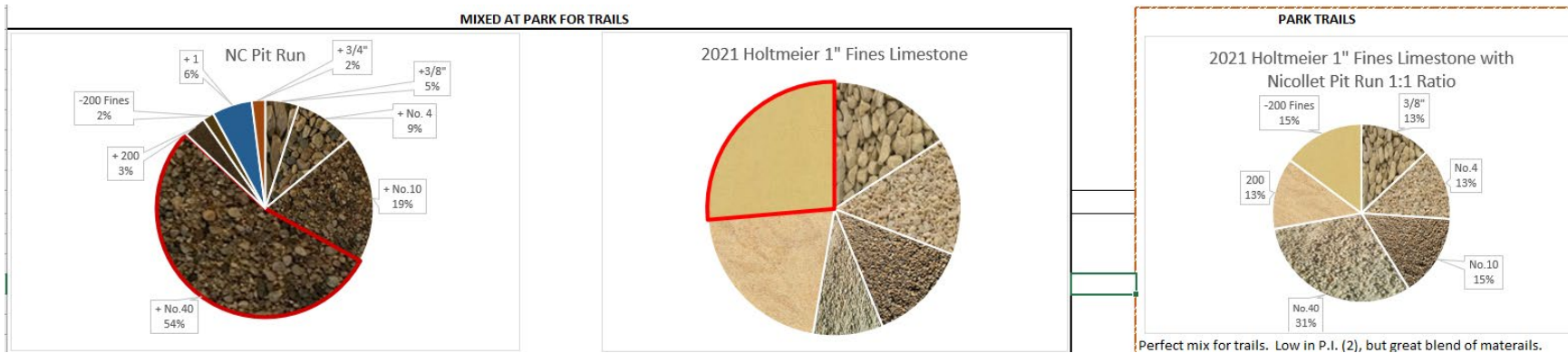
Rocks	48%
Sand	52%

2013 Nicollet Class 7B 30% RecBit 70% Gravel



Rocks	30%
Sand	70%

Theoretically Mixing Materials



Current Gravel Specification

(2111) AGGREGATE BASE

The provision of MnDOT 2111 are supplemented as follows:

Production requirements for **Stockpile Aggregate Surfacing Class 5MOD** are as follows:

Stockpile Aggregate Surfacing Class 5MOD will conform to the requirements of 3138 for Virgin Class 5 Surfacing Aggregate (100% passing the ¾" sieve).

Table 3138-3 is modified to require that 6-12% passes the No. 200 sieve for Class 5.

Stockpile Aggregate Surfacing Class 5MOD requires a minimum clay content of 3% and a Plasticity Index of 6-12.

Contractor's sampling and testing will be in accordance with Specification 3138.3 along with the following:

- G Particle Size Analysis Laboratory Manual Method
- H Liquid Limit Determination Laboratory Manual Method
- I Plastic Limit Determination Laboratory Manual Method

→ Contractor is required to provide Quality Control (QC) testing for gradation at a rate of 1/1000 tons produced into the stockpile. Percent crushing test is required 1/day. Tests results shall be provided to the County.

Contractor is required to verify that the minimum clay content and Plasticity Index are being met. Contractor shall have the aggregate material tested at the start of production to verify the minimum clay content and Plasticity Index meet the requirements of **S-17.3**. These parameters shall be verified after the initial passing test at a rate of 1/5,000 tons produced into stockpile. Test results shall be provided to the County. Failing Plasticity Index tests will require the Contractor to immediately make adjustments to production and to take another Plasticity Index test. While the Plasticity Index test is being completed production must cease. Once a passing Plasticity Index test is achieved the testing rate will resume at 1/5,000 tons.



Gradation, clay content, and Plasticity Index tests shall be performed by personnel that have MnDOT certifications to do so. Contractor shall provide to the County copies of the tester's MnDOT certification card.

The County may take companion aggregate samples to complete verification testing for gradation, percent crushing, minimum clay percent, and Plasticity Index.

Material represented by failing tests may be subject to reduced payment per Table 2211-4. Material with failing plasticity test may be subject to reduced payment.

NOTE: Contractor may need to supplement, from an outside source, the County's virgin pit material with oversize rock to meet the coarse sieve and crushing requirements. All costs to provide this material shall be included in the bid price for Aggregate Surfacing Class 5MOD.

Binder material shall meet the requirements of 3146 and special provision S-17.3.

NOTE: The County Gravel Pit does not contain binder material that meets the requirements of 3146 and special provision S-17.3. Contractor will be required to provide binder material from an outside source that meets the requirements of 3146 and special provision S-17.3. Cost to provide this material shall be included in the bid price for Stockpile Aggregate Surfacing Class 5MOD.

The contractor is required to provide and utilize a cone crusher to produce the Stockpile Aggregate Surfacing Class 5MOD.

No adjustment will be made in the contract unit price regardless of the amount of material crushed.

Mining locations shall be directed by the Engineer.

Stripping required to access suitable crushing material shall be incidental to 2111.509 Stockpile Aggregate Surfacing Class 5MOD.



Seth Greenwood P.E. / Nicollet County CL5Mod

Atterberg Test for P.I.

Plasticity Info



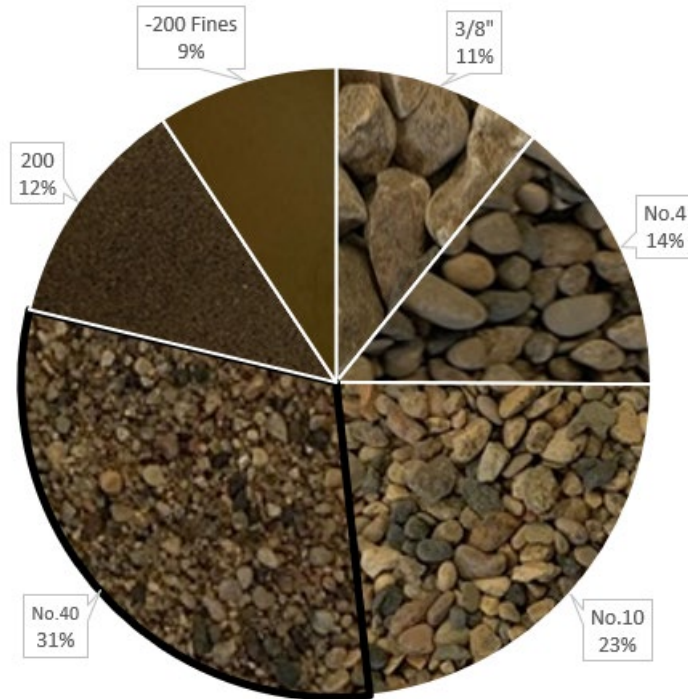
- “Good surface gravel needs a percentage of plastic material, usually natural clays, which will give the gravel a “binding” characteristic and hence a smooth driving surface. This is critical during dry weather.”
FHWA G.R.C.&M 3:10 Fines and Plasticity, pg 64

	Binder Options					
	Sandy Loam from NC Courtland Pit	Tan Clay from NC Courtland Pit	Tan Clay from Ulland Pit	Red Clay from NC Courtland Pit	Tan Clay from West Newton	Black Dirt from field off of CSAH 52
3/4 Rock						
3/8 Rock	15					
No. 4 Rock	20					
No. 10 C Sand	0.4	5.1				
No. 40 F Sand	5.2	22.9				
-200	94.4	72				
% of Silt in -200	83	41.1				
% of Clay in -200	11.4	30.9				
Plasticity Limit	27.5	18	18	18	17	34
Plasticity Index	10-32	1.1 ★	20	15	13	9
Liquid Limit	0-50	28.6	37	33	31	26
						48

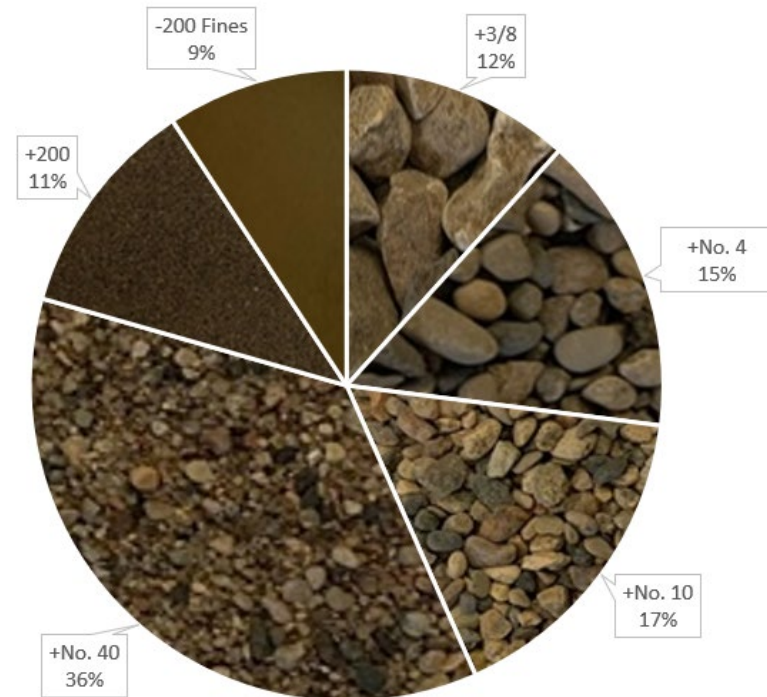
Sample Details				Particle Size Distribution		
Sample ID	20-27846-S9			Method:	MnDOT 1202, MnDOT 1203	
Field Sample ID	Class 5 #49			Drying by:	Natural	
Date Sampled	11/18/2020			Date Tested:	11/19/2020	
Source	Nicollet County Pit			Tested By:	Bryce Boyer	
Material	Natural Gravel					
Specification	MNDOT 3138-3 CL 5 Agg Surface Nic Cty					
Sampling Method	Sampled by Contractor					
Location	49,000 Tons					
Date Submitted	11/19/2020					
Other Test Results				Sieve Size	% Passing	Limits
Description	Method	Result	Limits			
Approximate maximum grain size	ASTM D 4318			1/4in (19.0mm)	100	100
Material retained on 425µm (No. 40) (%)		75.2		5/8in (16.0mm)	100	
Method of Removal				1/2in (12.5mm)	93	
Grooving Tool Type				3/8in (9.5mm)	84	50 – 90
Specimen preparation method				No.4 (4.75mm)	67	35 – 80
Drying Method				No.10 (2.0mm)	55	20 – 65
Special selection process				No.30 (600µm)	32	
Rolling Method for PL				No.40 (425µm)	25	10 – 35
As Received Water Content (%)				No.100 (150µm)	16	
Liquid Limit Device Type		Manual		No.200 (75µm)	12.6	6 – 13.5
Liquid Limit		26				
Plastic Limit		18				
Plasticity Index		8	6 – 12			
Liquid Limit Procedure		One-point (B)				
Date Tested		11/24/2020				
Granular Ratio						

Retained in Lieu of Passing Test Results

1988 Nicollet Class 1 Gravel



2020 Nicollet MNDOT Class 5 Mod Max 3/4"



Rocks	48%
Sand	52%

2016 Class 5Mod
 200: 6 -12% (13.5 MAX)
 (P.I.) Plasticity Index: 6-12

2016 Class 5Mod Results



Hardpan = Reduced Maintenance



Gravel Use Formula

- “**One ton of aggregate** per mile is lost each year for each vehicle that passes over a road daily.”

FHWA G.R.C.&M 4.5: Reduced Gravel Loss pg 79

- “One car making one pass on one mile of dirt or gravel road one time each day for one year creates **one ton of dust.**” *Environmentally Sensitive For Dirt and Gravel*

Roads, pg 70

- Example:

- 88 cars x 11.2 miles x 1 ton x 1 year = 986 tons of gravel loss per year on that road

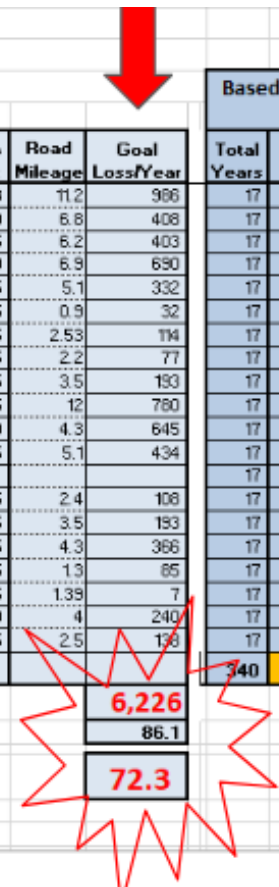
Gravel Use Spreadsheet

GRAVELING GRAVEL ROADS - 12-0200 (Gravel Road Usage Goal)
17 YEAR HISTORY
IN TONS

Road	Actual Gravel Used																Total	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021		2022
4	2,849	1,052	660	1,078	2,123	2,969	3,080	1,694	-	1,192	1,480	-	1,406	1,913	4,632	-	674	26,228
7	704	2,334	814	55	374	2,970	990	902	44	288	176	6,051	-	-	65	-	-	15,767
18	33	-	1,628	506	2,090	-	-	319	1,502	-	704	1,500	80	1,071	-	-	2,709	9,433
19	407	704	1,822	275	1,584	1,353	1,353	-	8	240	-	3,321	30	266	3,338	326	116	15,027
52	968	550	-	110	737	638	869	-	1,432	324	384	481	390	1,040	-	-	-	7,913
56	363	44	86	341	55	209	11	-	-	112	72	-	-	50	366	-	62	1,711
57	902	-	473	165	-	858	275	-	-	-	-	-	1,420	-	-	1,507	-	5,600
59	-	637	33	781	792	715	-	-	-	16	680	-	-	-	78	-	-	3,732
60	22	-	11	-	407	1,331	825	-	803	-	-	-	1,336	-	-	-	-	4,735
61	1,529	167	3,531	627	266	1,265	4,202	2,211	11	2,272	728	1,354	650	74	621	-	-	19,548
62	176	44	517	-	-	264	2,079	198	660	96	40	808	-	880	884	312	734	6,958
63	275	28	1,463	308	1,904	1,419	330	-	-	768	648	-	160	40	517	-	-	7,760
64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	247	-	247
65	22	-	143	792	319	-	605	-	-	858	-	-	-	-	128	-	36	2,865
70	66	370	297	121	1,056	77	803	-	-	152	-	-	-	531	-	-	10	3,473
75	-	538	308	-	891	253	1,705	473	-	848	384	1,464	-	403	706	2,431	132	10,404
76	-	363	-	-	44	-	418	-	-	280	-	-	-	790	-	-	-	1,895
78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104	-	-	104
82	-	33	660	1,210	319	22	341	-	308	832	-	-	-	700	-	-	-	4,425
88	-	77	44	165	1,056	33	990	-	-	-	-	-	-	910	-	-	-	3,275
	8,316	7,001	12,492	6,534	13,937	13,661	19,591	5,797	5,048	7,996	5,296	16,315	6,526	6,268	11,499	4,823	4,473	151,100
	Average Total Gravel per Year -																9,444	
Miles	85.82	85.8	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
Tons / Mile	97	82	145	76	162	159	227	67	59	93	61	189	76	73	134	56	52	106
	Avg Per Mile																106	

Traffic Count	Road Mileage	Goal Loss/Year
88	11.2	966
60	6.8	408
65	6.2	403
100	6.9	690
65	5.1	332
35	0.9	32
45	2.53	114
35	2.2	77
55	3.5	193
65	12	760
150	4.3	645
85	5.1	434
-	-	-
45	2.4	108
55	3.5	193
85	4.3	366
65	1.3	65
5	1.39	7
60	4	240
55	2.5	158

Based on Traffic Counts		
Total Tons		
Total Years	17 Year Goal	Over / (Short)
17	16,755	9,473
17	6,936	8,831
17	6,851	2,582
17	11,730	3,297
17	5,636	2,278
17	536	1,176
17	1,935	3,665
17	1,309	2,423
17	3,273	1,463
17	13,260	6,286
17	10,965	(4,007)
17	7,370	391
17	-	247
17	1,836	1,029
17	3,273	201
17	6,214	4,191
17	1,437	459
17	118	(14)
17	4,080	345
17	2,338	938
17	105,849	45,251



Gravel Quantity

- Per the “Gravel Formula” the yearly plan is to use 6,000 - 8,000 tons on gravel roads by the following methods for 86.12 miles.

Year 1: **1400** / 1.4 = 1000 * 27 = 27,000 / 24 / 5280 =
.213 x 12 = 2.55” deep (2 Belly Dump wide)

Year 10: **700** / 1.4 = 500 * 27 = 13,500 / 24 / 5280 =
.1065 x 12 = 1.27” deep (1 Belly Dump wide)

Year 20: **700** / 1.4 = 500 * 27 = 13,500 / 24 / 5280 =
.1065 x 12 = 1.27” deep (1 Belly Dump wide) Repeat....

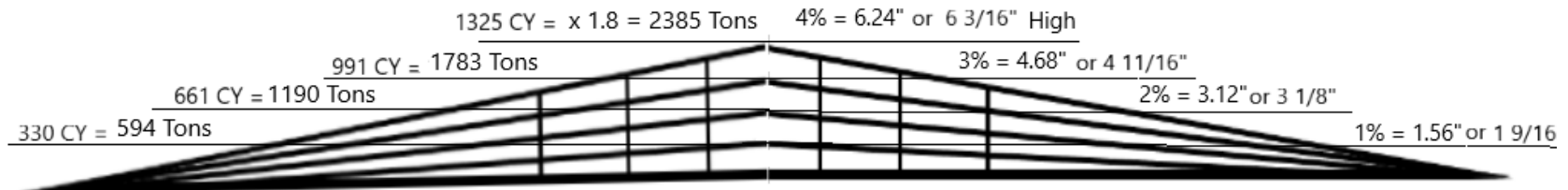
Old Plan: **300** / 1.4 = 214 * 27 = 5,785 / 24 / 5280 =
.0456 x 12 = .54” deep (only 1/3 of original design)

Crown Formula

- Tons / Mile for 1%

Total Road Width	26	Ft
Use 1/2 road width to create a rectangle vs 2 triangles	2	
Half Road Width	13	Ft
Length	5280	Ft
Subtotal	68640	Sqft
Slope: 1/2" / ft rise over run 6.5"	0.52	Height
Rectangle	35692.8	Cf
Conversion for Cubic Yard	27	
	1321.95	CY
Conversion for compacted tons	1.8	
	2379.52	Tons
4% Slope Total	4	
Tons per mile per slope	594.880	Tons

Conversion of 1.8 for Compacted Gravel



26' Wide Gravel Surface Top

Operating Standards

- 3-5 MPH
- 30-45° Moldboard Angle (mark the circle)
- Blade Pitch:
 - Tilted Back: Cutting
 - Middle: Mixing / Spreading
 - Tilted Forward: Spreading and Light Blading
- 4% Slope (rooftop) and 6% on Super Curves
- Wet Blades
 - +.3" of rain
 - 1 time every 4-8 weeks, typically
 - 1" - 2" deep cut into road and do whole section of road to remove washboard
- Dry Blades
 - -.3" Of rain
 - 1 time every 1-4 weeks, typically
 - Spot blade bad areas; typ. intersections, hills, and shift points
- 2 Pass vs 6 Pass Maintenance Techniques
- Maintaining Techniques for Spring, Summer, and Fall
- NOTE: Each operator does things a little different, but the end goal is the same.



Ditch and Shoulder Maintenance

NACE (National Association of County Engineers)

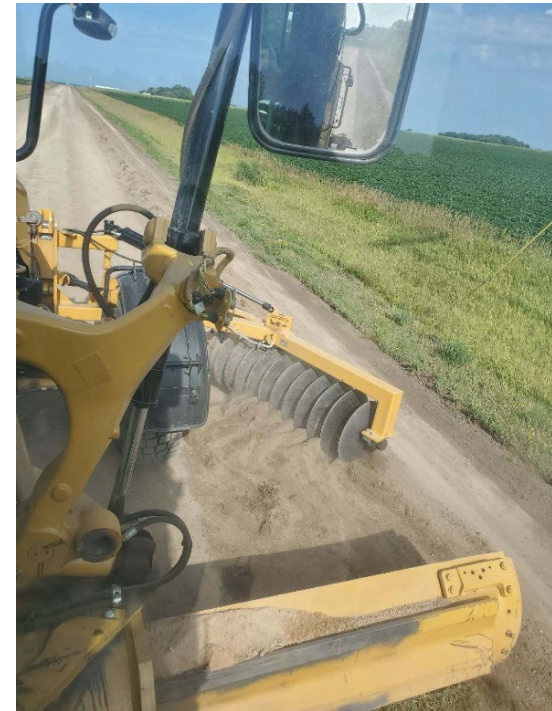
- “Blade shoulders as needed to recover loose aggregate and valuable fines and to destroy vegetation.”
- “Spread loose aggregate and fines from shoulder across road surface to help build the crown and stabilize surface aggregate”

Blading Aggregate Surfaces, FHWA, To blade shoulders , pg18
(1974-1990)

Reclaimers



Similar to fall tillage in fields.



Beginners: Secondary ditches, shoulders, and sod clumps
Advanced: In-slopes & mixing reclaim

Packer/Rollers



Similar to land rollers



Walk 'N' Roller for all blades

Ditch Issues

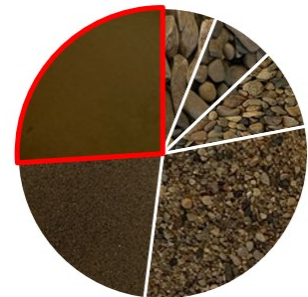
- Proactive ditch cleaning started in 2018



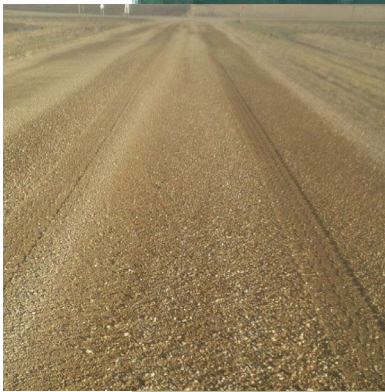
Past Road Surface Issues



Excessive Binder Placed On The Road From Reclaiming Shoulders



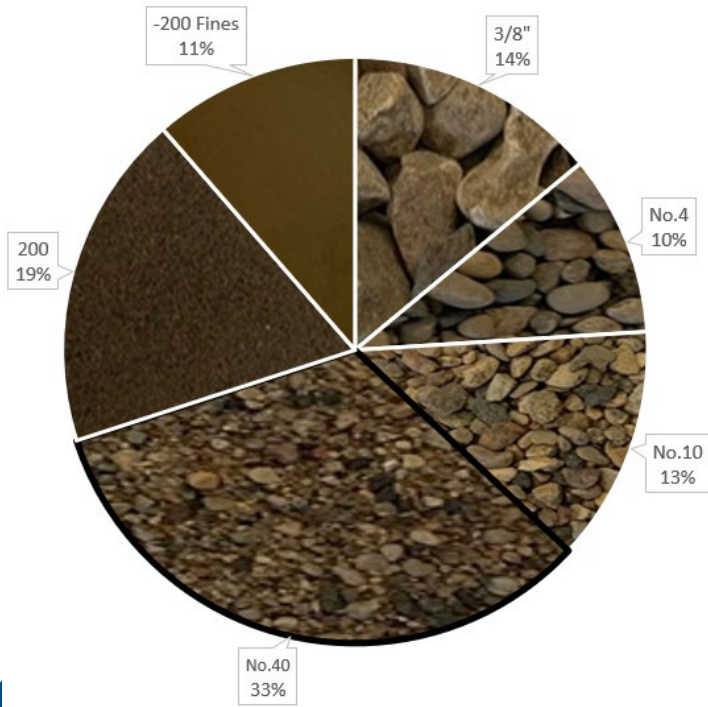
Past Road Surface Issues



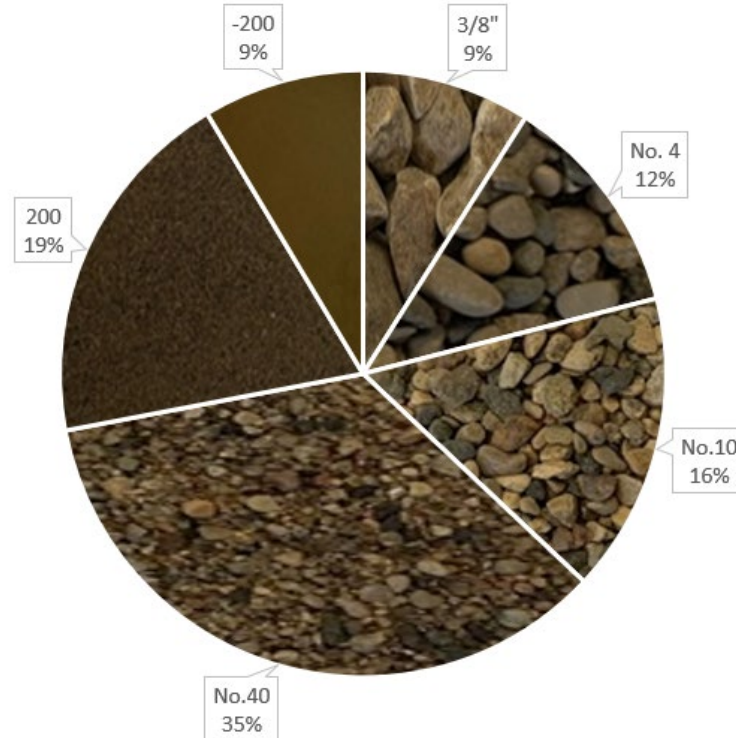
Excessive Loose Surface Rock

Past Road Surface Issues = Rejuvenated Mix

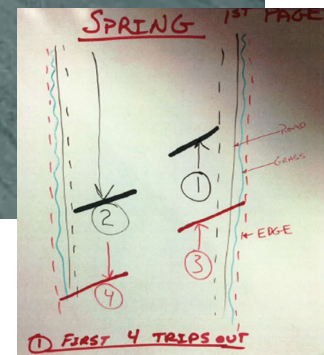
1995 Nicollet Class 1 Gravel



Reclaim Mix 2021 CNTY 82



Yearly Maintenance



March- April
Shape Roads

Yearly Maintenance



April - May
Shape Roads & Disk

Yearly Maintenance



May – June 15th

Routine Maintenance &

Mix Reclaim on dry days and pack on shoulder

Yearly Maintenance



Blend in the Reclaim
(YOU NEED 3 DRY DAYS AFTER DOING THIS)



Scrape the Reclaim
(Optional)

Yearly Maintenance



Finished Reclaim Mix



Yearly Maintenance



June – October
Routine Maintenance &
Cover the Reclaim w/New CL5Mod 900
tons/mile 9-28-2017



Yearly Maintenance



June - October
Dry Weather Blading



Winter



Rule of 3's



- .3" OF RAIN
 - Perfect amount of moisture for blading
- 3 BLADE CYCLES
 - To level all new and rejuvenate gravel
- 3 DRY DAYS
 - Required to "Bake" to create hardpan

1. It takes 3 days of dry weather for farmers to plant beans after a rain.
2. Sometimes, the topsoil can get hard enough to create a crust to prevent seedlings from emerging

Office Results

Reduced operating hours by 46%
3,342 hrs to 1789 hrs

Reduced gravel use by 50%
15,132 tons to 7,522 tons
175.71 tons / mile to 87.35 tons / mile

LRRB (RIC-13) 2024 - 2025

- Gravel Road and Shoulder Maintenance
 - Stonebrooke Engineering
 - Principle Investigator: John Brunkorst P.E.
 - Co- Investigators: Rick West & Britt Berner
- Public Agency Champion: Nicollet County
 - Technical Liaison: Michael Suska

Thank you!

Michael Suska

Assistant Public Works Director M.&O.

michael.suska@co.nicollet.mn.us

507-934-7725

Gravel Team:

Nicollet County Public Works Director: Seth Greenwood P.E.

Public Works Accountant: Thomas Goblirsch

Supervisor: Devron Havemeier

Blade Operators: Kyle Peterson, Matt Bode, Matt Mickelson

NICOLLET
COUNTY EST. 1853



Mission Statement

Providing efficient services with innovation and accountability.

Vision Statement

Setting the standard for providing superior and efficient county government services through leadership, accountability and innovation to a growing and diverse society.

Leadership. Efficiency.
Accountability.
Innovation. Integrity.