South Dakota Gravel Study
A 2011 Success Story

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SD LTAP

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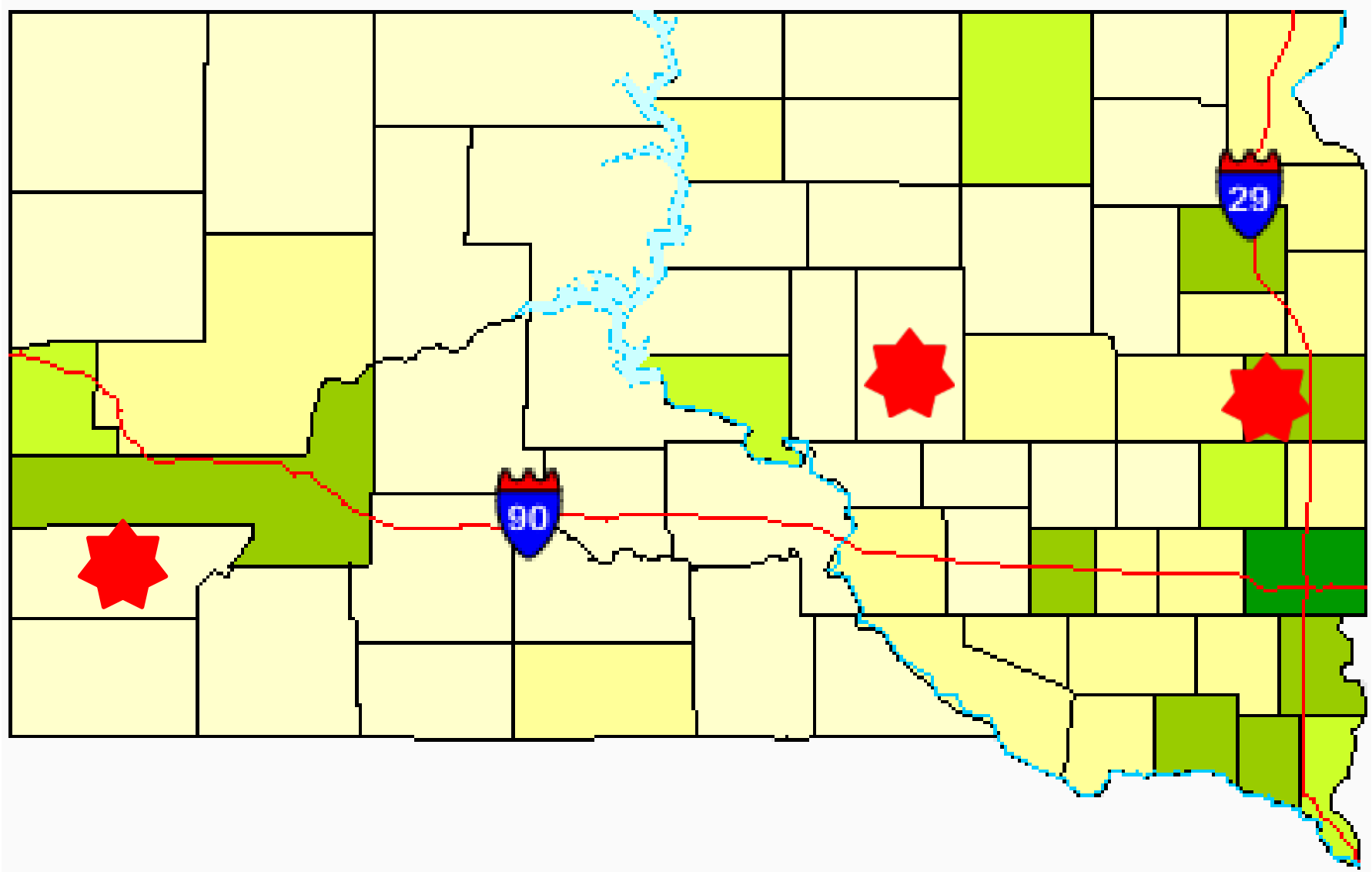
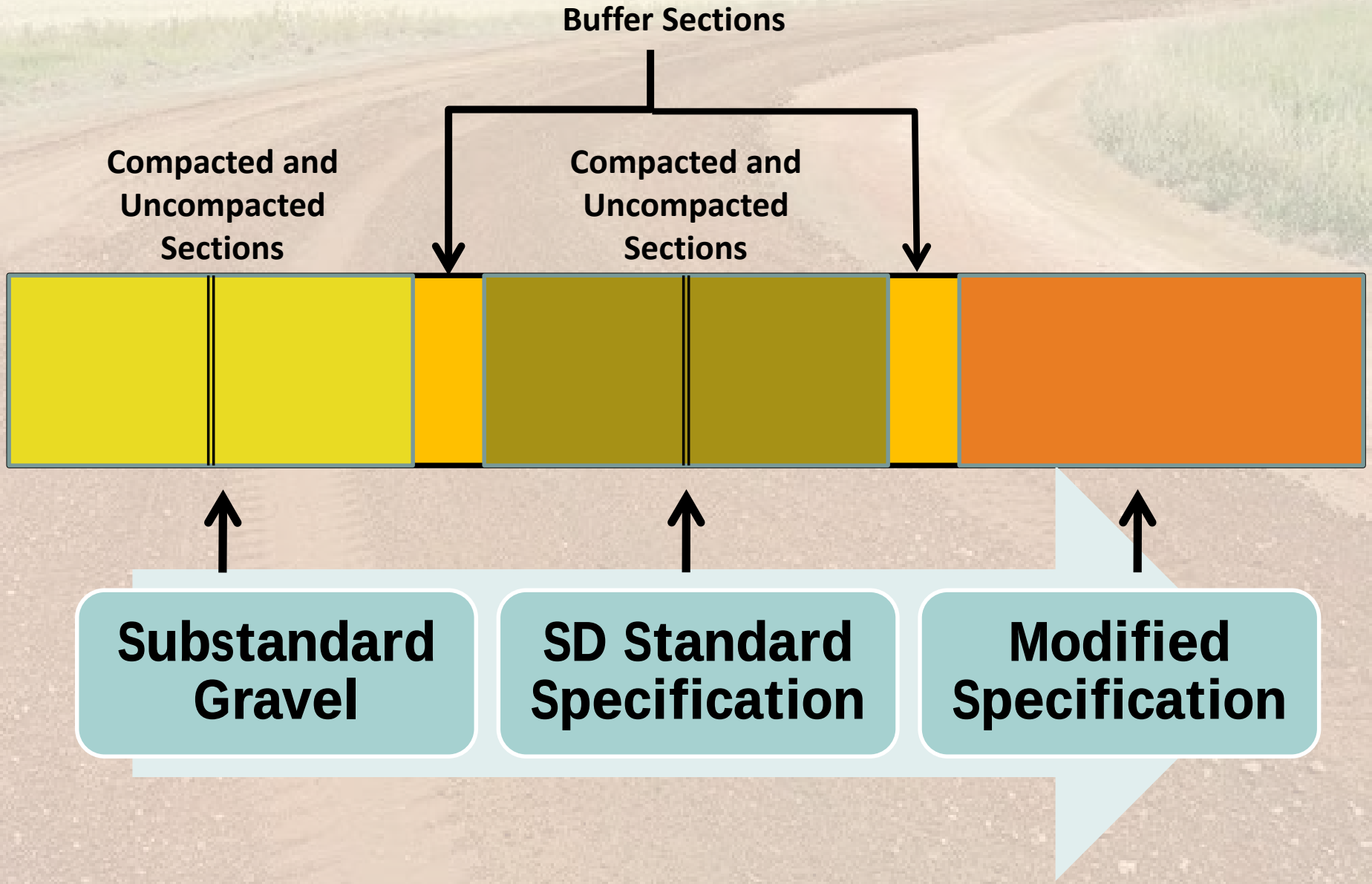
SDDOT/SDLTAP Gravel Road Experimental Project Lessons Learned Thru 2017

SDDOT Gravel Road Test Project

- Three test sections were constructed in:
  - Hand County – northeast of Miller
  - Custer County – northwest of Custer
  - Brookings County – south of Volga

Location of Sections:




Buffer Sections
Compacted and Uncompacted Sections
Compacted and Uncompacted Sections
Substandard Gravel
SD Standard Specification
Modified Specification

Each section was built with three to four inches of new gravel after existing surface was prepared and shaped. Compaction/non compaction comparison as well.

One of the biggest challenges was finding gravel that meets the modified SDDOT Specification: "Shall have minimum plasticity index (PI) of seven". (Even higher minimum was considered in project planning)

Gravel Road Test Project

- **Primary focus is on effect of gravel quality on life-cycle cost of gravel road maintenance**
- **Three types of gravel used in study:**
  1. **Substandard but commonly used – meets no spec except top size control – one inch minus.**
  2. **Barely meets SDDOT Gravel Surfacing Spec – percent passing #200 sieve is low and/or plasticity index (PI) at bottom of range at 4**
  3. **Modified SDDOT Spec – higher minimums of 10% passing #200 sieve and PI at 7.**

What is Good Gravel?

SDDOT Standard Specifications- Base/Surface Gravel

TABLE 1

REQUIREMENT	Subbase	Gravel Cushion	Aggregate Base Course	Limestone Ledge Rock		Gravel Surfacing
				Base Course	Gravel Cushion	
SIEVE	PERCENT PASSING					
2" (50 mm)	100					
1" (25.0 mm)	70-100		100	100		
3/4" (19.0 mm)		100	80-100	80-100	100	100
½" (12.5 mm)			68-91	68-90		
No. 4 (4.75 mm)	30-70	50-75	46-70	42-70	46-70	50-78
No. 8 (2.36 mm)	22-62	38-64	34-58	29-53	29-53	37-67
No. 40 (425 µm)	10-35	15-35	13-35	10-28	10-28	13-35
No. 200 (75 µm)	0.0-15.0	3.0-12.0	3.0-12.0	3.0-12.0	3.0-12.0	4.0-15.0
Liquid Limit Max		25	25	25	25	
Plasticity Index	0-6	0-6	0-6	0-3	0-3	4-12
L.A. Abra. Loss, max.	50	40	40	40	40	40
Foot Notes		2	1,2			
Processing Required	crushed	crushed	crushed	crushed	crushed	crushed

Base – Surface Gravel 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

Better when modified to 8 - 15

From *South Dakota Standard Specifications.* (16)

Sampling and testing is the only way to be sure.

Cost Of Good Gravel

- As is the cost of everything good, gravel is not an exception !!!!
- Analyzing cost of the gravels life cycle is very important
- Is slightly more expensive gravel that requires 10 less blading's per year really more expensive?
- Giving the public a safe road at a reasonable cost is very important!

How Do We Obtain Good Gravel

- Contractor
- Pit Selection
- Managing the Source
- Testing
- Managing the Stockpile

Pit Selection

- Availability of Good Material
- Option To Bring In Material To Meet Spec
- Cost of Material
- Location of Pit (Reduced Haul Costs)

Contractor

- Is the Contractor Familiar With the Area
- Willing To Meet Spec
- Willing To Test or Be Tested
- Process In A Suitable Time Frame

Testing

- Taking Tests
- Timely Testing
- Who Pays For the Test
- Does It Meet Spec
- What if It Is Out of Spec?
- Cost of Test

Control quality at the time of production.

One way to meet modified spec – blend different material from separate sources

This was done on one section in Brookings Co and one section in Custer Co

More blending or “manufacturing” in the future?

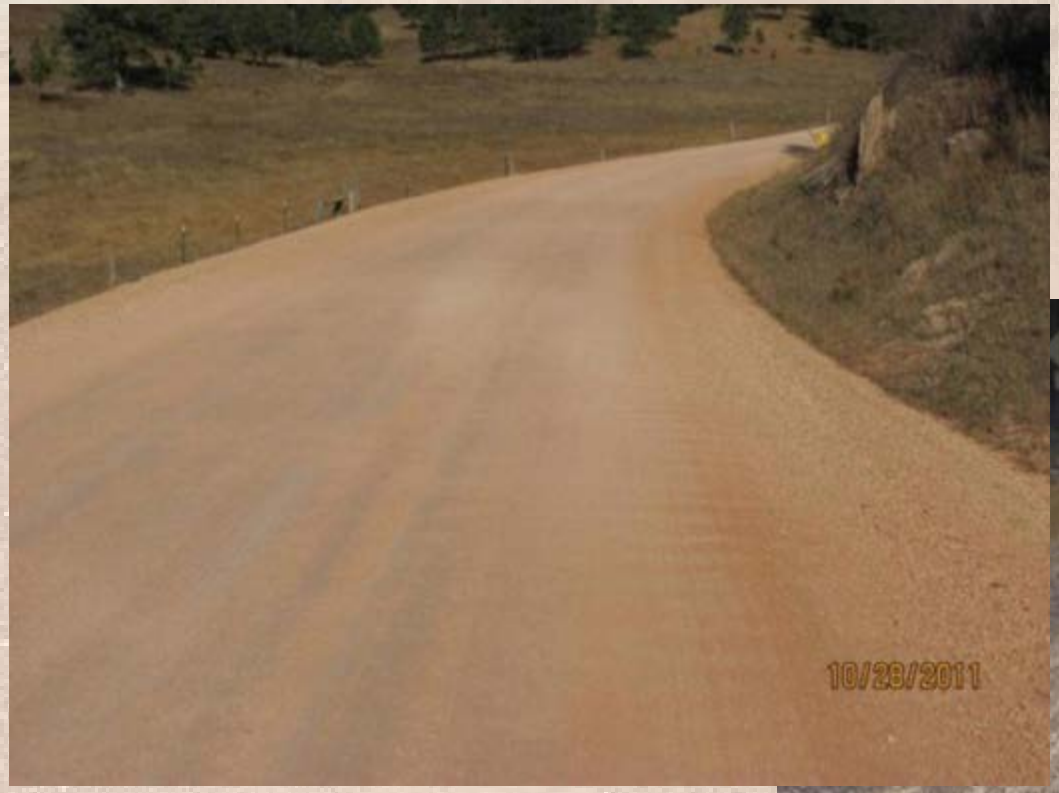
Processing material from a natural clay source

Road mixing to get a high quality surface gravel


CAT


140H

Some sections showed contrast in performance quickly due to gravel quality



Custer County Test Sections

Brookings County Test Sections

Only <u>one month</u> after construction

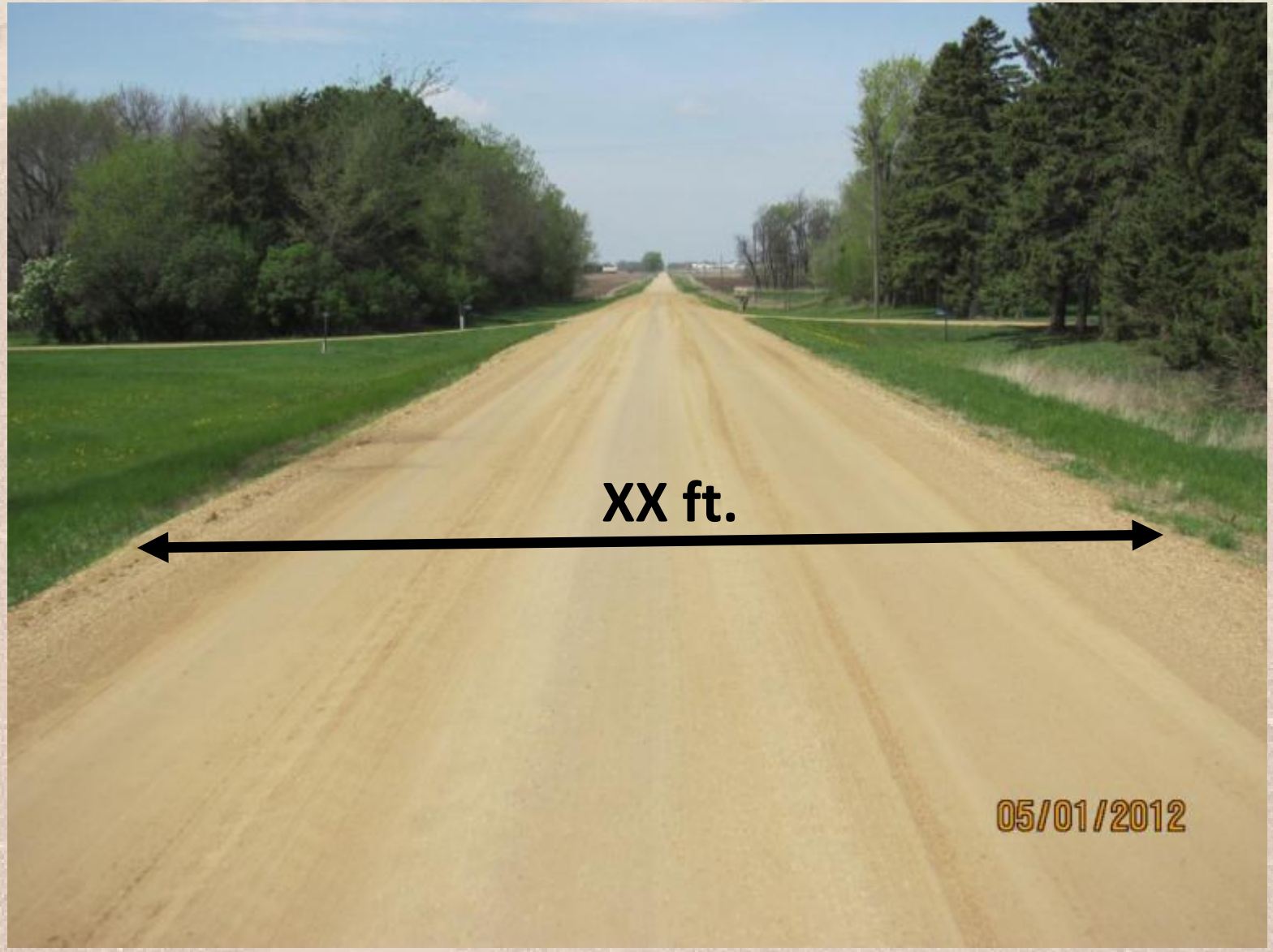
Current Status of Project

- SDLTAP has accumulated photo documentation on all sections over the past two years.
- Measurement and documentation has been done on these distress types in 2012:
  1. Accumulation of loose aggregate (float)
  2. Changes in top width from time of construction
  3. Presence of corrugation (washboard) on surface
  4. Change in roadway crown

The float test

Simply remove loose aggregate from a 10 inch cross section, weigh it and convert that to a one-mile section

Change is top-width is measured on traveled way – grass line to grass line



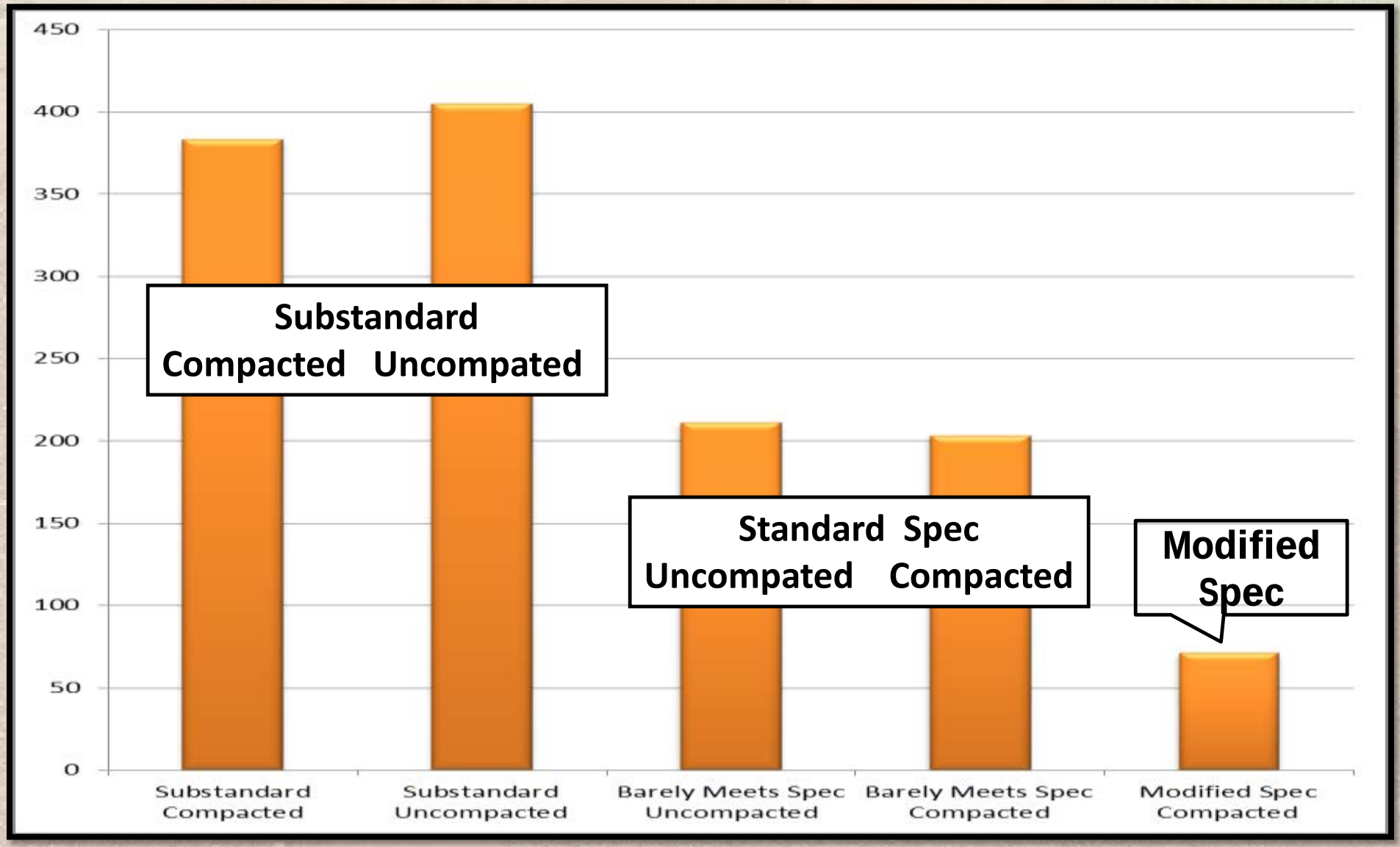
Corrugation (washboard): Hard to quantify in extent, fairly easy to measure severity

Crown:
measured with a laser level

Summary of Loose Aggregate

- **Brookings Section – measured 10-10-12:**
  - Substandard Compacted: 383 tons per mile
  - Substandard Uncompacted: 405 tons per mile
  - Standard Spec Uncompacted: 211 tons per mile
  - Standard Spec Compacted: 203 tons per mile
  - Modified Spec Compacted: 71 tons per mile

Brookings Section – Loose Aggregate

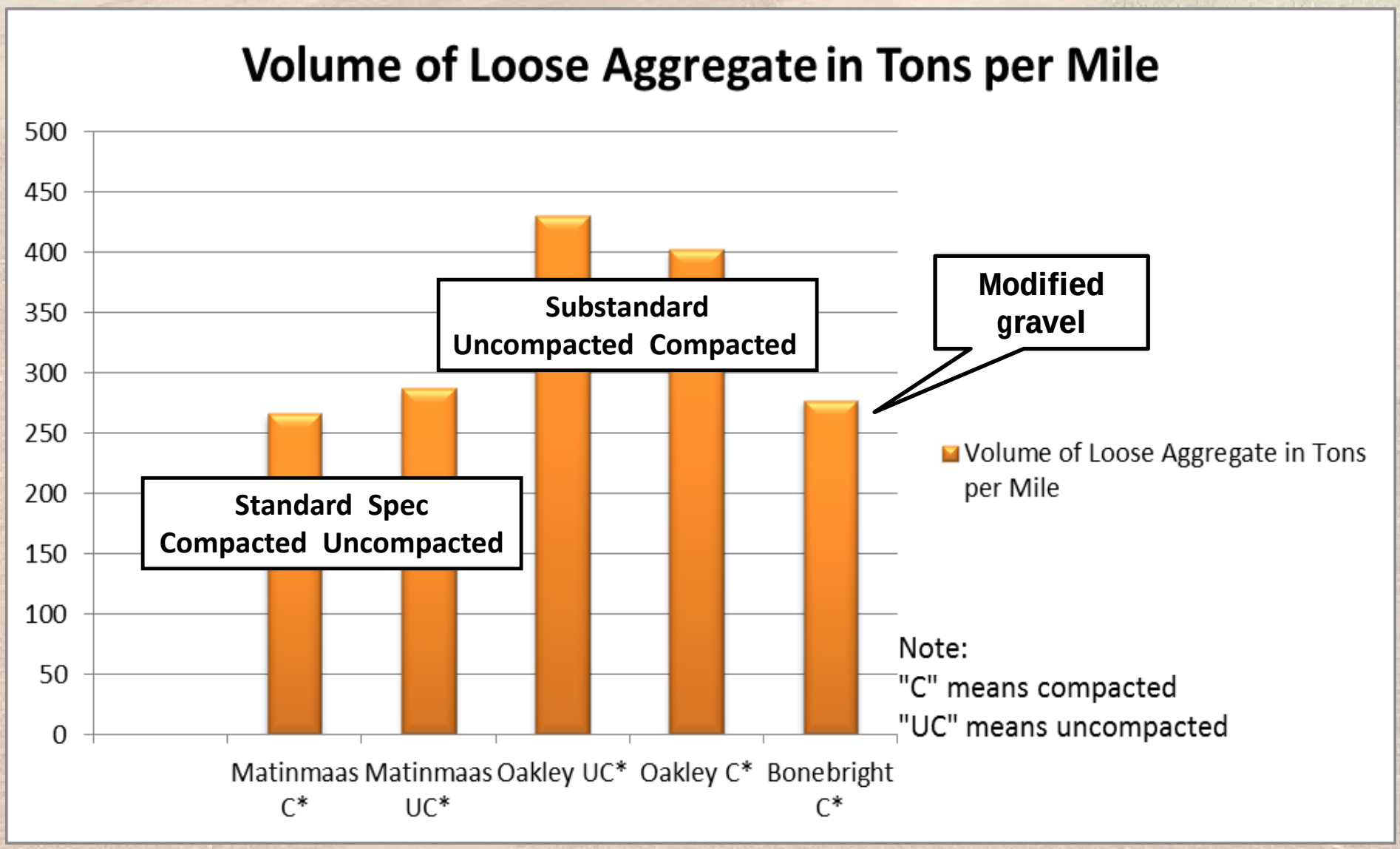


Summary of Loose Aggregate (Con't)

- **Hand Co Section – measured 9-11-12**
  - Substandard Compacted: 430 tons per mile
  - Substandard Uncompacted: 402 tons per mile
  - Standard Compacted: 266 tons per mile
  - Standard Uncompacted: 287 tons per mile
  - **Modified Spec Compacted: 277 tons per mile

  ** Testing showed gradation and plasticity varied little from Standard

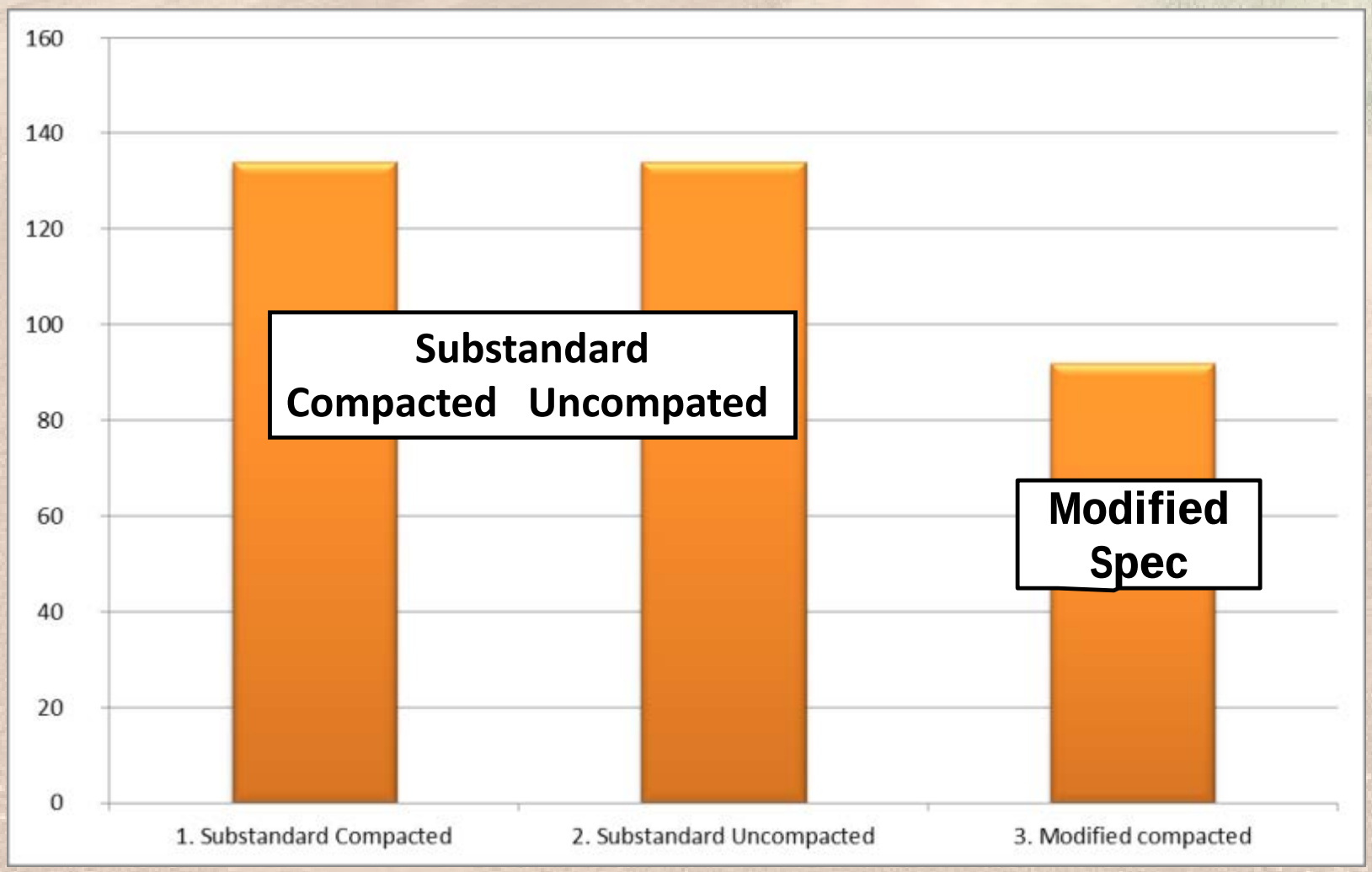
Hand Section – Loose Aggregate



Summary of Loose Aggregate (cont.)

- **Custer Co Section – measured 10-16-12**
  - Substandard Compacted: 134 tons per mile
  - Substandard Uncompacted: 134 tons per mile
  - Modified Compacted: 92 tons per mile

Custer Section – Loose Aggregate



Deviation in Roadway Width*

- **Brookings Section:**
  - Modified section: **21 ft, 6 in**
  - Substandard section: **24 ft, 7 in**
- **Hand Section:**
  - Modified section: **24 ft, 6 in**
  - Substandard section: **26 ft, 10 in**
- **Custer Section:** No measurement due to uneven cross section

*** Width deviation measured after harvest 2012.**

Corrugation (Washboard)

- No corrugation observed on any sections meeting at least minimum standard specification.
- However, Brookings substandard section had corrugation on 100% of center wheel path at last observation.
- Custer substandard did not have corrugation.

Concluding Points

- Meeting basic SDDOT standard surface gravel specification reduces loose aggregate by 1/3 to 1/2.
- Widest differential was in Brookings County near end of corn harvest with **405 tons** of loose aggregate on substandard section to only **71 tons** on modified section.
- Most interesting fact thus far: **Brookings has done blade maintenance up to four times on substandard section to only once on modified!**

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QUESTIONS?

THANK YOU

FOR YOUR

TIME