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Pavement Quality Indicators

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Pavement Quality Indicators

Five Year Report (2009-2013)

for

The Nebraska Department of Roads

Research Technician: Connor Villanueva

Advisor: Prof Wayne Jensen



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16. Abstract <p>The Nebraska Department of Roads (NDOR) conducts an annual examination of pavement conditions on Nebraska's interstate and federal highway system. During these examinations, indicators of pavement quality are measured directly or compiled from parameters recorded by a vehicle passing over the pavement sections. A number of pavement sections where experimental methods and/or materials have been incorporated were selected by the NDOR for comparison to nearby conventional pavement sections. This study used data recorded by the NDOR as well as field observations to compare two similar pavement sections, one which incorporated experimental methods and/or materials during construction and the second of more conventional design.</p> <p>Pavement quality indicators measured and compared include Nebraska Serviceability Index, International Roughness Index, Present Serviceability Index, rutting, faulting, and cracking. Indicators were evaluated with regard to whether experimental strategies were beneficial or detrimental to pavement quality during the lifespan of each pavement section.</p>			
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The authors would like to thank Dave Medinger from the NDOR for providing detailed information concerning the various pavement parameters from the appropriate database. Many other individuals from the NDOR's Materials and Research Division also made significant contributions to the researcher's efforts including Jodi Gibson, Lieska Halsey, Wally Heyen, Dan Nichols, Robert Rea, Mick Syslo, and Brandon Varilek.

Introduction

The Nebraska Department of Roads (NDOR) has introduced a number of experimental pavement strategies into the Nebraska Highway System over the past ten years. These strategies have involved incorporating new materials or methods into the pavement construction process. Strategies have included gap graded, terminal blended and modified crumb rubber binders, bituminous foundation courses, two different specifications for microsurfacing, high reclaimed asphalt pavement (RAP) bases, fibermat reinforcement between pavement layers, and various combinations of these and other technologies. Experimental strategies were incorporated to determine if each would produce pavement that performed better under imposed loads and/or exhibited increased lifespan.

Specific pavement sections where experimental technologies have been incorporated were selected by the NDOR for comparison to similar but more conventional pavement sections. Comparison sections were selected based upon close proximity where possible to ensure similar traffic loading. In the worst case scenario, comparison sections were selected based upon similar average daily traffic volumes.

This study sought to document the advantages or disadvantages of using various experimental strategies by measuring distress indicators (PSI, IRI, cracking, rutting, etc.) at regular points during each pavement's lifespan. This study utilized data concerning pavement parameters collected by the NDOR as part of their annual pavement evaluation studies. Researchers documented site visits to pavement sections by measuring various physical parameters associated with pavement quality as well as by digital photography. Information from the two sources was merged and analyzed to determine whether experimental or conventional pavement was performing in a superior manner.

How the NDOR Measures Pavement Quality

The Nebraska Department of Roads (NDOR) conducts annual examinations of the Nebraska's interstate and federal highway pavements. During these examinations, numerous indicators of pavement quality are measured directly or are compiled from parameters recorded by a vehicle passing over the pavement section. Parameters are documented and analyzed for each one-tenth mile segment. This study used data recorded by the NDOR as well as field observations to develop a standardized comparison between two similar pavement sections. Information about these quality indicators will be referenced throughout this report. The quality indicators measured and the conditions of each which relate to various levels of service are shown below.

Nebraska Serviceability Index (NSI): Overall surface condition of pavement rated on a subjective scale of 0-100.

Very good:	90 & Over	Age of pavement:	
Good:	70—89	6-10 years:	Max NSI = 92
Fair:	50-69	Over 10 years:	Max NSI = 88
Poor	30-49		
Very Poor	0-29		

International Roughness Index (IRI): Pavements smoothness is measured as vertical millimeters per lateral meter (mm/m).

Very smooth:	0.0—0.85
Smooth:	0.86—2.48
Moderately rough:	2.49—3.33
Rough	3.34—4.21
Very Rough	4.22 & Over

Present Serviceability Index (PSI): AASHTO index indicating the functional ability of the pavement to serve the public, based on roughness, with 5 being best and 0 worst.

Very Good:	4.1—5.0
Good:	3.1—4.0
Fair:	2.1—3.0
Poor	1.1—2.0
Very Poor	0.0—1.0

Cracking Index: Approximate percentage of bituminous surfacing (BIT) that is cracked or the percentage of PCC (Portland Cement Concrete) panels which are cracked.

Good	0—30
Fair	30—50
Poor	Over 50

Rutting: Average rut depth for a bituminous surface expressed in millimeters (mm).

Good	Less than 4	$7 \leq \text{Rutting} < 8$	Max NSI = 92
Fair	4—9	$8 \leq \text{Rutting} < 9$	Max NSI = 71
Poor	Over 9	$9 \leq \text{Rutting}$	Max NSI = 60

Faulting: The amount of displacement between two adjacent slabs measured at the common joint or structural crack in millimeters (mm). Pavement with faulting in excess of 6 mm is considered poor quality.

Longitudinal Cracking: Longitudinal cracking denotes cracks that run predominantly parallel to the centerline. These cracks may be in the wheel paths, between wheel paths and/or at lane joints such as near the centerline or shoulder.

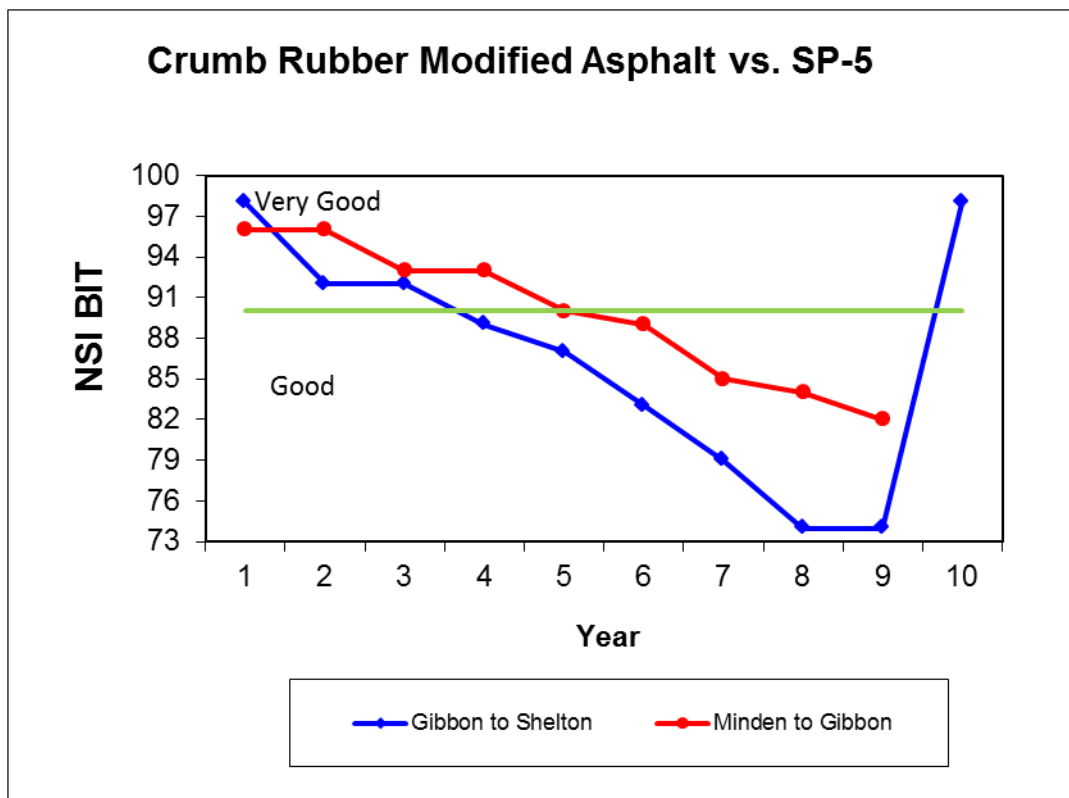
Transverse Cracking: Cracks that run perpendicular to centerline, resulting in a panel that is broken into two or more pieces. Panels broken into two pieces are rated Class I and panels broken into more than two pieces are rated Class II.

Experimental and Comparison Sections

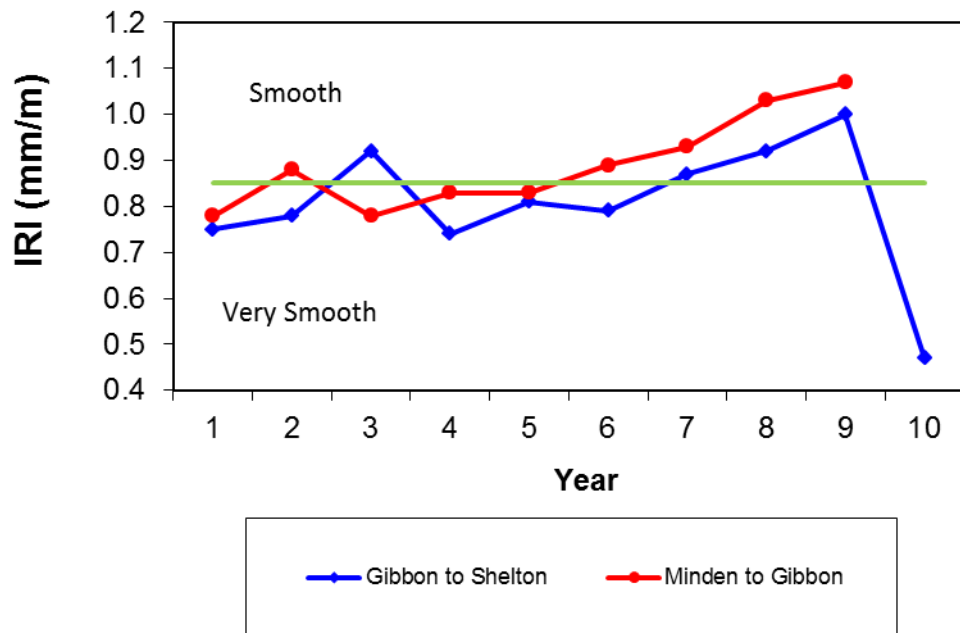
Experimental Section	Age	HWY	CN	R.P.	Strategy	Conventional Section	Age	HWY	CN	R.P.	Strategy
Gibbon to Shelton	8/1	I-80	42117	283.70-290.97	1.5" Gap Graded Crumb Rubber over 2.5" SP-5 in driving lanes; passing lanes have 1.5" GGCRM	Minden to Gibbon	9	I-80	42156	279.48-283.70	4" of SP-5 in driving and passing lanes
US-20 to N-59	1	14	31582	170.97-179.14	2" overlay of GGCRMLV (low volume)	South Jct. of N15 - WCL Plymouth	8	4	11890	133.58-144.03	SP-4 Special Mix, 3.5" thick
Berywn to Ansley	9	2	60894	287.35-294.36	White topping; 8" of dowled PCC over milled asphalt roadbed	Ansley to Mason City	11	2	60792	295.89-301.76	White topping; 9" of non-doweled PCC over milled asphalt roadbed
Alma to Republican City	7	136	70591	29.56-37.50	7" of SP-4 over 4" bituminous foundation course	Republican City to Naponee	5	136	70591A	37.50-41.59	4" of SP-4 over 10" FA stab bit (small section of 10" SP-4 on prepared subgrade)
Louisville East Plattsmouth West	5	66 66	22204 22225	112.07-118.50 118.50-124.84	2" SP-4, 3 3/4" High RAP Base 2" SP-4, 3 3/4" High RAP Base	Malmo Spur West	5	79 & 92	12819	N-79: 22.48- 23.50 N-92: 437.75-442.77	2.5" of SP-4 over 4" Hyd Lime Slurry Stab base
Rulo West	3	159	12995	3": 4.87-5.34, 6.34-11.51, 12.43-13.34/ 1.5": 5.34-6.34, 11.51-12.43	3" SP-4 (Term Blend CR Binder) Mill 1.5"/Fill 1.5" SP-4 GTR Bind Mill 3"/Fill 3" SP-4 GTR Binder	Newcastle	4	12	31798	222.25-233.96	Mill 2-3"/Fill 3" SP-4 Special
Lyons North	3	77	31974	148.77-163.91	Microsurfacing (new spec.)	Lincoln East	4	34	19908C	332.64-341.48	Microsurfacing (old spec.)
US-81 to Leigh	3	91	31899	153.53-163.98 & 164.67-165.33	Mill 4"/Fill 4" High RAP Base. 2" Gap Graded Crumb Rubber Modified AC	Emerson to N. of Wakefield	3	9	31877	30.53-37.38	Mill 4"/Fill 4" HRB 2 1/2" SP-4
Bennet North	3	43	13017	15.46-16.74	Mill 2"/Fill 2" SP-4 w/Dry Crumb Rubber Modified Binder	Lewiston E&W	4	4	12821	167.47-179.55	Mill 2"/Fill 2" SP-4 Special
Leigh to Dodge Cty Line	3	91	31985	165.33-182.85	Mill 2"/Fill 2" SP-4 w/Wet Crumb Rubber Modified Binder	Superior South	3	14	42544	0.00-1.90, 2.85-7.32	2" SP-4, 3" SP-4
Ogallala South	3	61	61436	78.68-81.71 81.71-82.71 82.71-85.11	1.5" Sp-4 on 1.5" HRB (no Fibermat) 1.5" SP-4 on Fibermat on 1.5" HRB 1.5" SP-4 on 1.5" HRB on Fibermat	N-92 to N-64	4	81	42440	95.26-104.80	2" SP-4 on non-woven fabric on 2" SP-4 over existing PCC
Phillips-Giltner (new)	1	I-80	42415	318.58-324.55	SP-5 with 5/8" leveling course plus a 1 3/8" layer	Big Springs West (new)	3	I-80	61285	102.09-106.31	SP-5 with a standard 2" overlay

Gibbon to Shelton vs. Minden to Gibbon

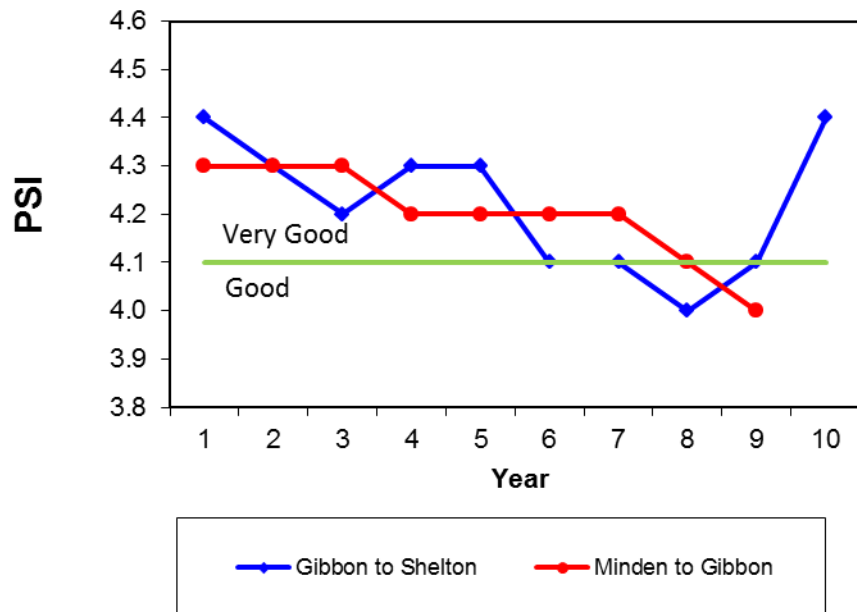
Comparison 1	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Gibbon to Shelton	8/1	I-80	42117	283.70-290.97	1.5" Gap Graded Crumb Rubber over 2.5" SP-5 in driving lanes; passing lanes have 1.5" GGCRM	
Conventional	Minden to Gibbon	9	I-80	42156	279.48-283.70	4" of SP-5 in driving and passing lanes	



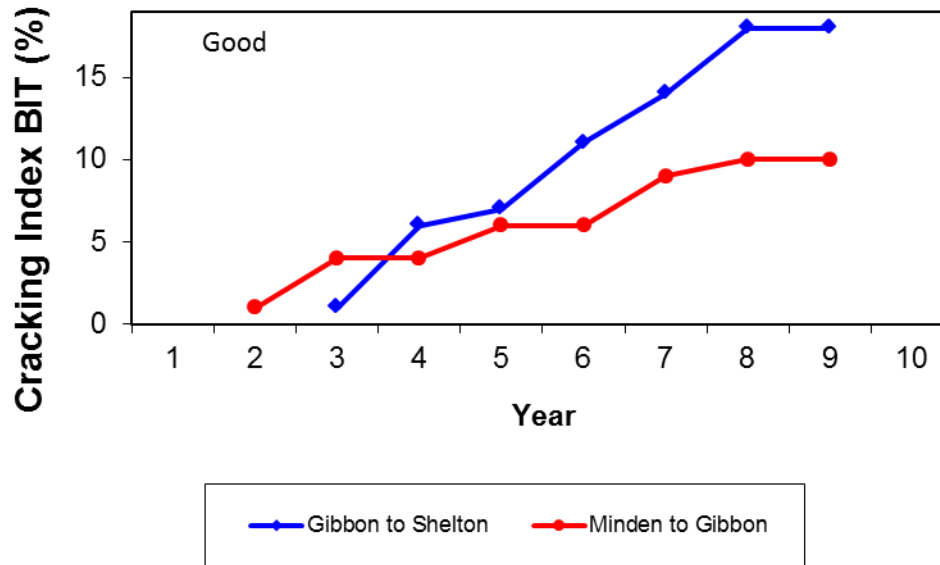
Crumb Rubber Modified Asphalt vs. SP-5



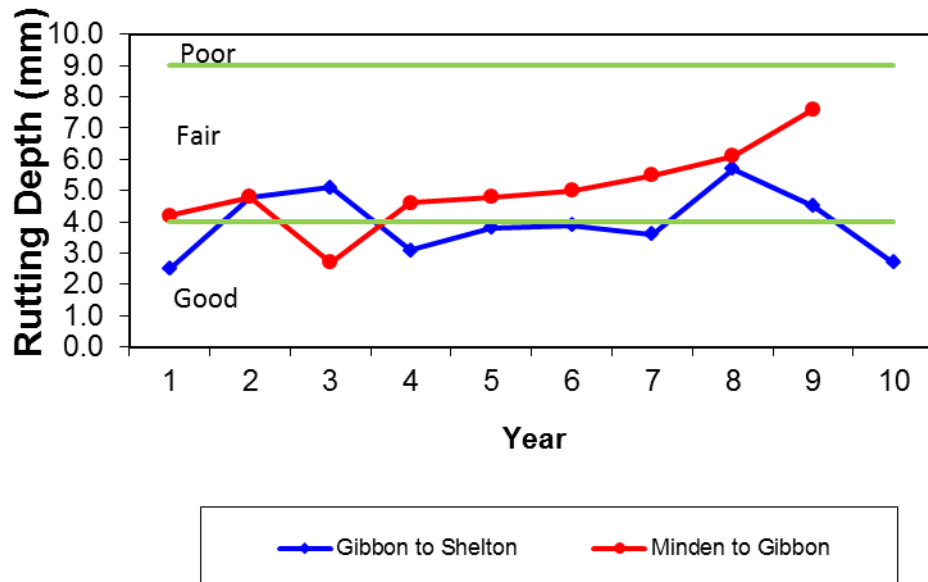
Crumb Rubber Modified Asphalt vs. SP-5



Crumb Rubber Modified Asphalt vs. SP-5



Crumb Rubber Modified Asphalt vs. SP-5



Gibbon to Shelton (Experimental)



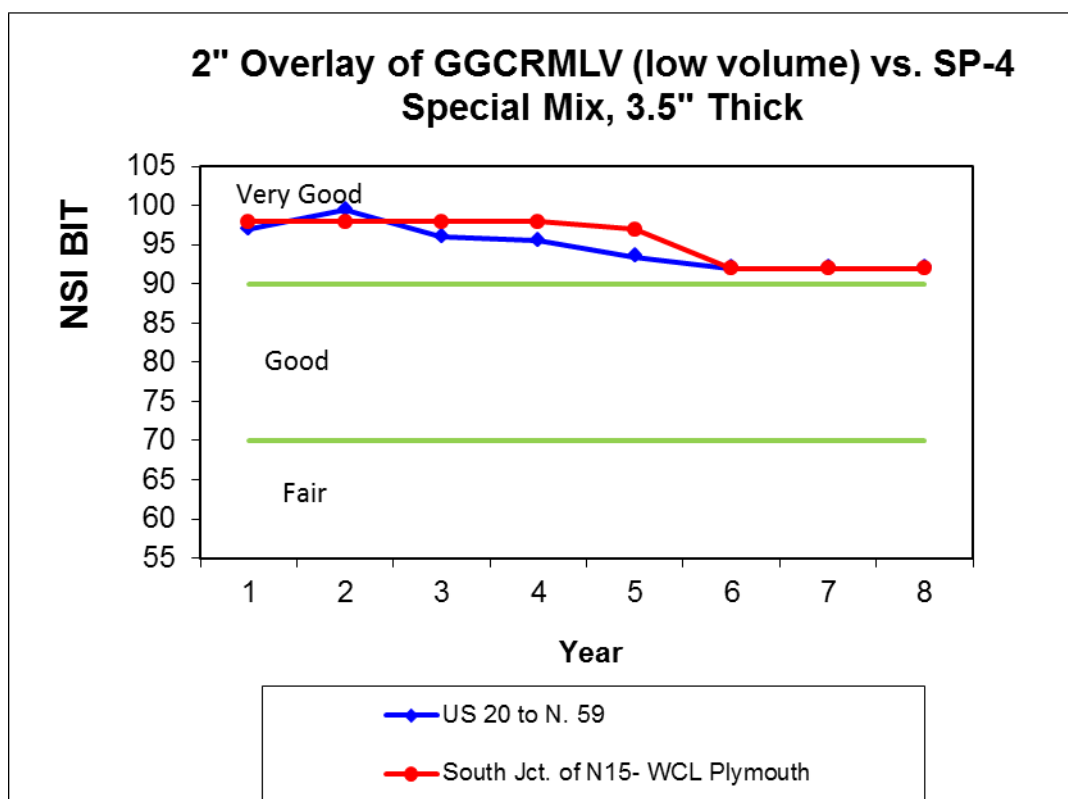
Minden to Gibbon (Conventional)



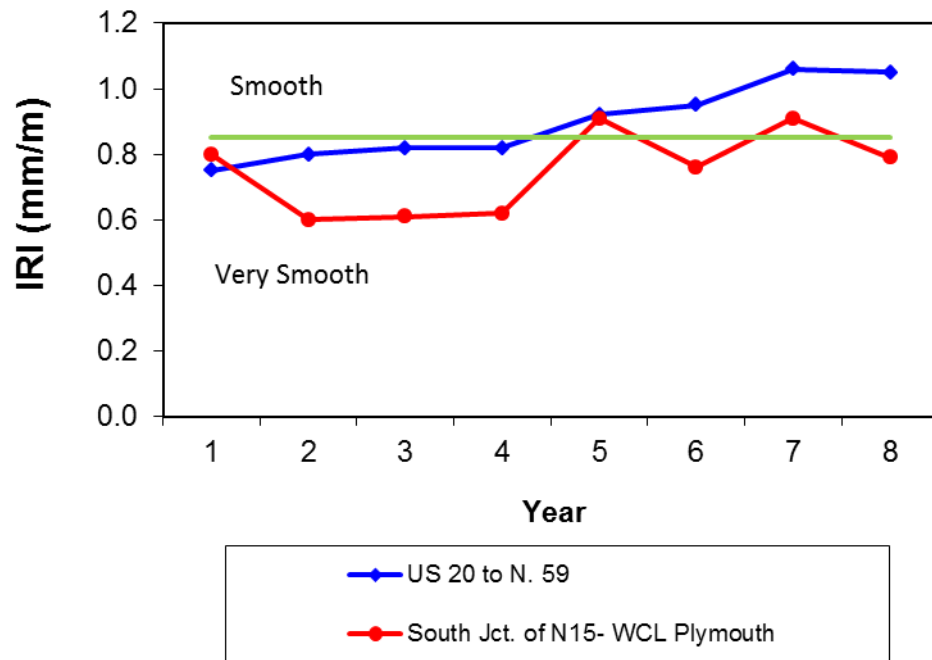
Summary: The experimental section (Gibbon to Shelton) was repaved in 2012. Over the past five years, Gibbon to Shelton, paved with crumb rubber modified (CRM) asphalt, visually exhibited more cracking and potholes than conventional asphalt (Minden to Gibbon). The conventional SP-5 section also outperformed the experimental section with regard to NSI and cracking. PSI varied from year to year, with the conventional pavement performing better for a year or two and then the experimental pavement exhibiting better performance over a similar timeframe. Rutting in the experimental section was equal to or less than rutting in the conventional section every year but two. IRI in the experimental section was equal to or less than rutting in the conventional section every year but one. Neither section exhibited performance that was clearly superior to its counterpart.

US-20 to N-59 vs. South Jct of N15 – WCL Plymouth

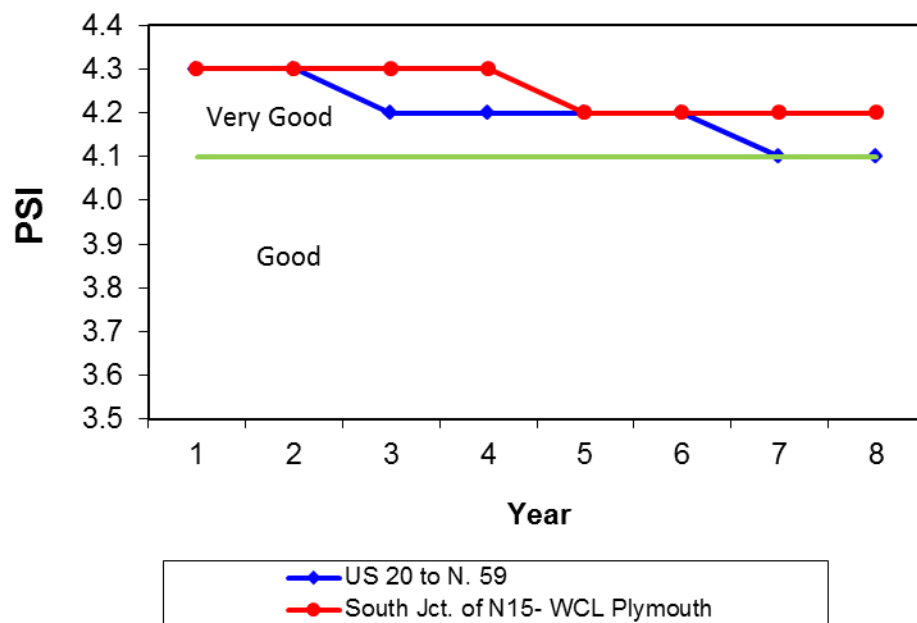
Comparison 2	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	US-20 to N-59	8	14	31582	170.97-179.14	2" overlay of GGCRMLV (low volume)	
Conventional	South Jct. of N15 - WCL Plymouth	8	4	11890	133.58-144.03	SP4 Special Mix, 3.5" thick	



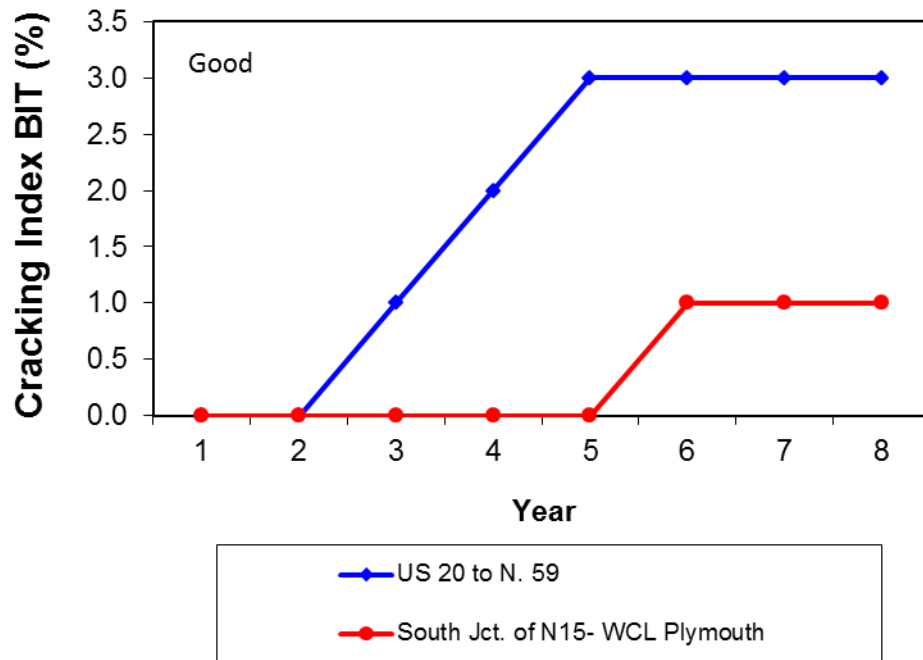
2" Overlay of GGCRMLV (low volume) vs. SP-4 Special Mix, 3.5" Thick



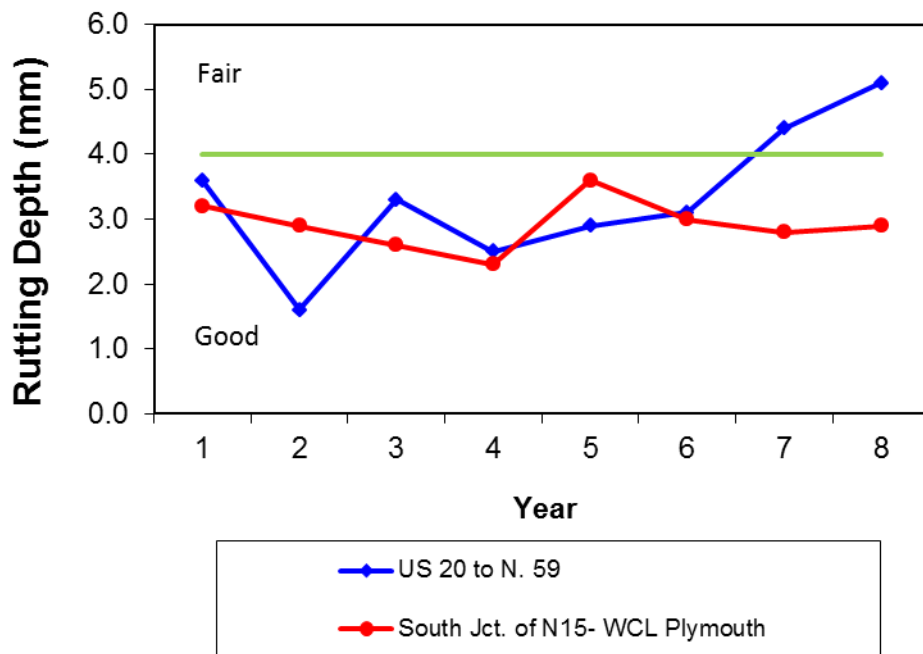
2" Overlay of GGCRMLV (low volume) vs. SP-4 Special Mix, 3.5" Thick



2" Overlay of GGCRMLV (low volume) vs. SP-4 Special Mix, 3.5" Thick



2" Overlay of GGCRMLV (low volume) vs. SP-4 Special Mix, 3.5" Thick



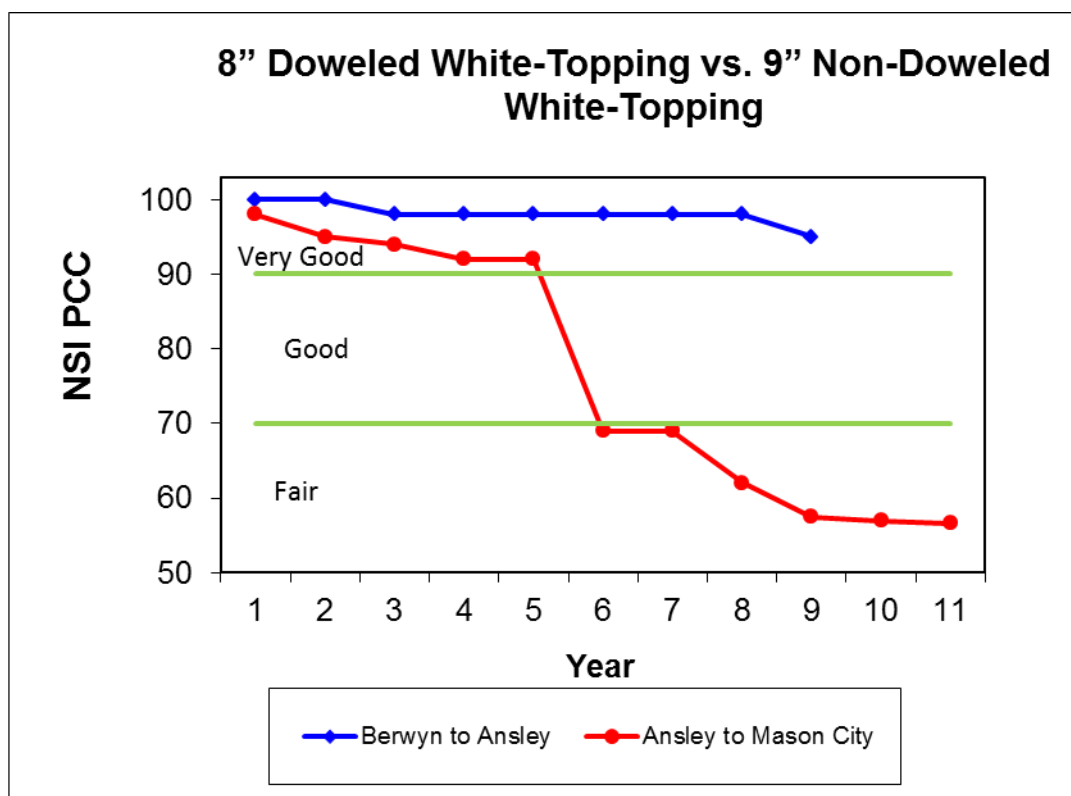
US-20 to N-59 (Experimental) South Jct of N15 – WCL Plymouth (Conventional)



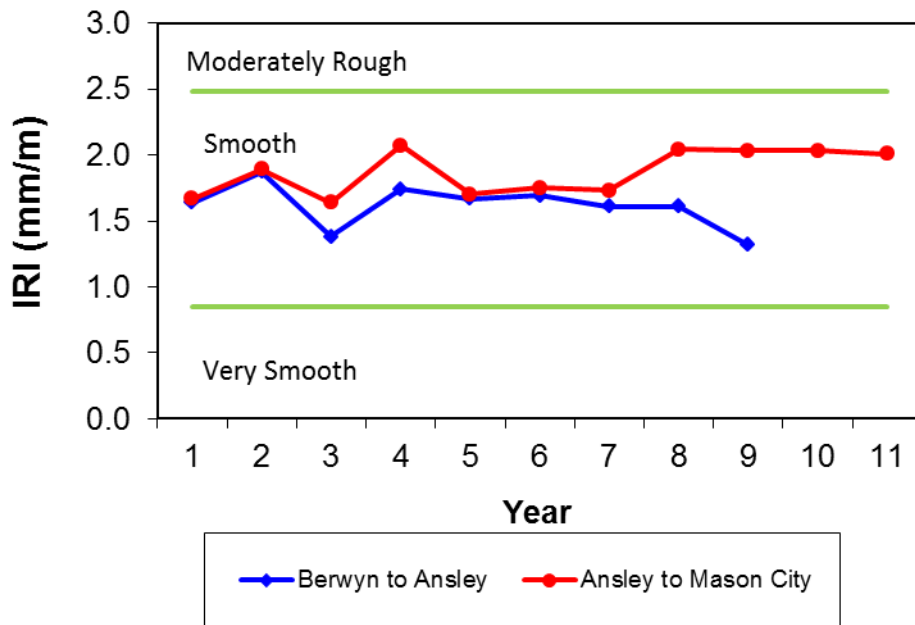
Summary: The conventional, 3.5" SP-4 section (South JCT of N15 to WCL Plymouth) and the experimental section (US-20 to N-59) with 2" gap-graded crumb rubber binder are performing in a similar manner with respect to the NSI. The NSI for these sections is now identical because of the age rule (after six years, $NSI \leq 92$). Conventional SP-4 appears to be outperforming the experimental pavement in at least three of the other four parameters. Conventional SP-4 shows consistently lower IRI and cracking, while exhibiting very similar to slightly higher PSI. Rutting within the two sections was essentially equal until two years ago, when the experimental section showed a significant increase. In summary, conventional SP-4 appears to be performing better with regard to four of five parameters, while performing in at least a similar manner with regard to NSI. Some or all of these results may originate from differences in pavement thickness versus being actual indicators of pavement quality.

Berwyn to Ansley vs. Ansley to Mason City

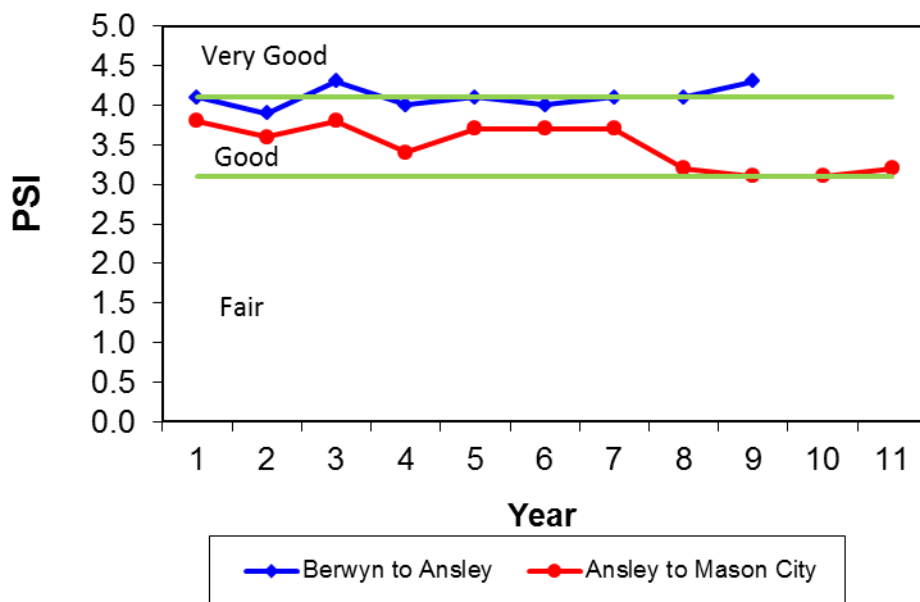
<i>Comparison 3</i>	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Berywn to Ansley	9	2	60894	287.35-294.36	White topping; 8" of doweled PCC over milled asphalt roadbed	
Conventional	Ansley to Mason City	11	2	60792	295.89-301.76	White topping; 9" of non-doweled PCC over milled asphalt roadbed	



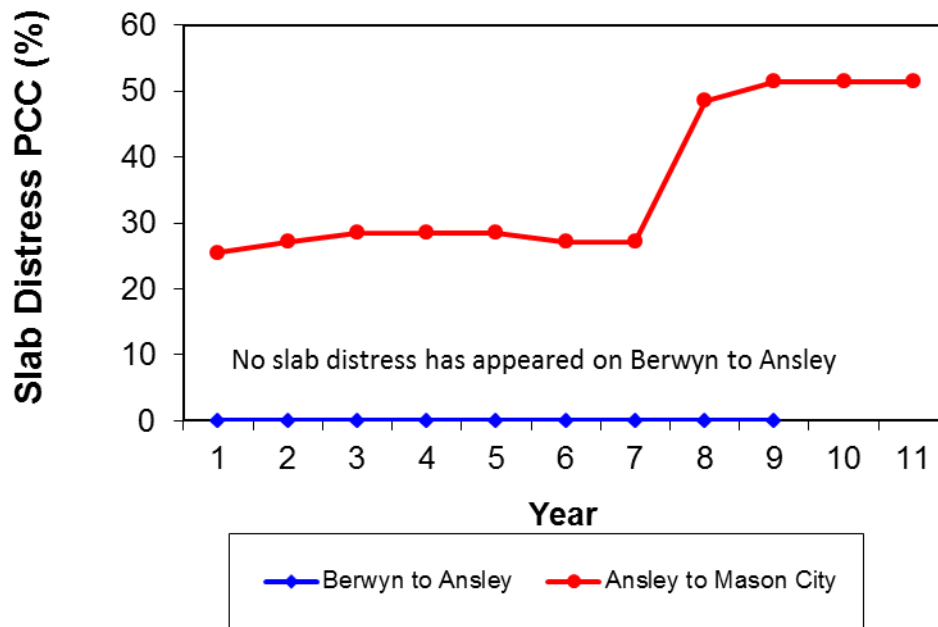
8" Doweled White-Topping vs. 9" Non-Doweled White-Topping



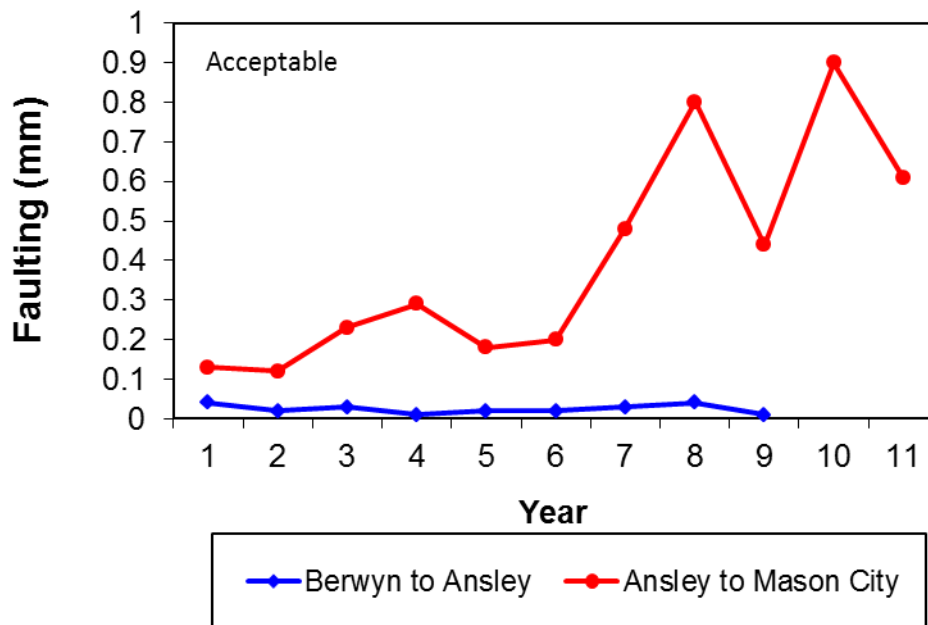
8" Doweled White-Topping vs. 9" Non-Doweled White-Topping



8" Doweled White-Topping vs. 9" Non-Doweled White-Topping



8" Doweled White-Topping vs. 9" Non-Doweled White-Topping



Berwyn to Ansley (Experimental)



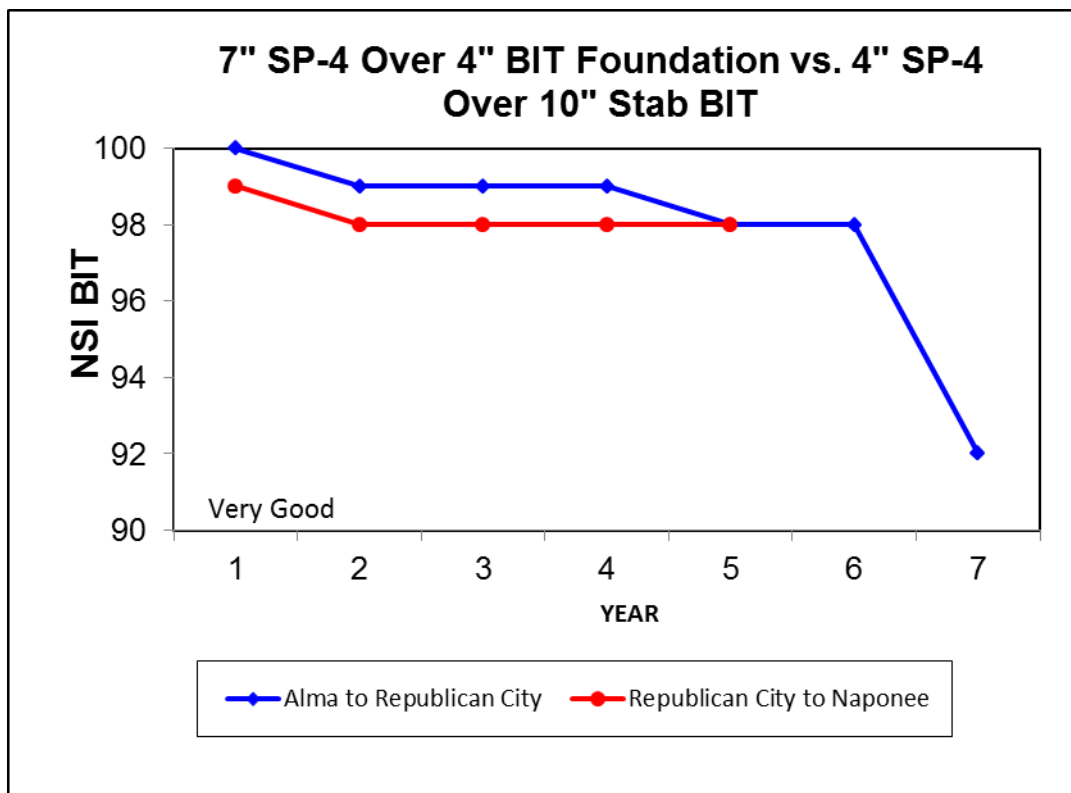
Ansley to Mason City (Conventional)

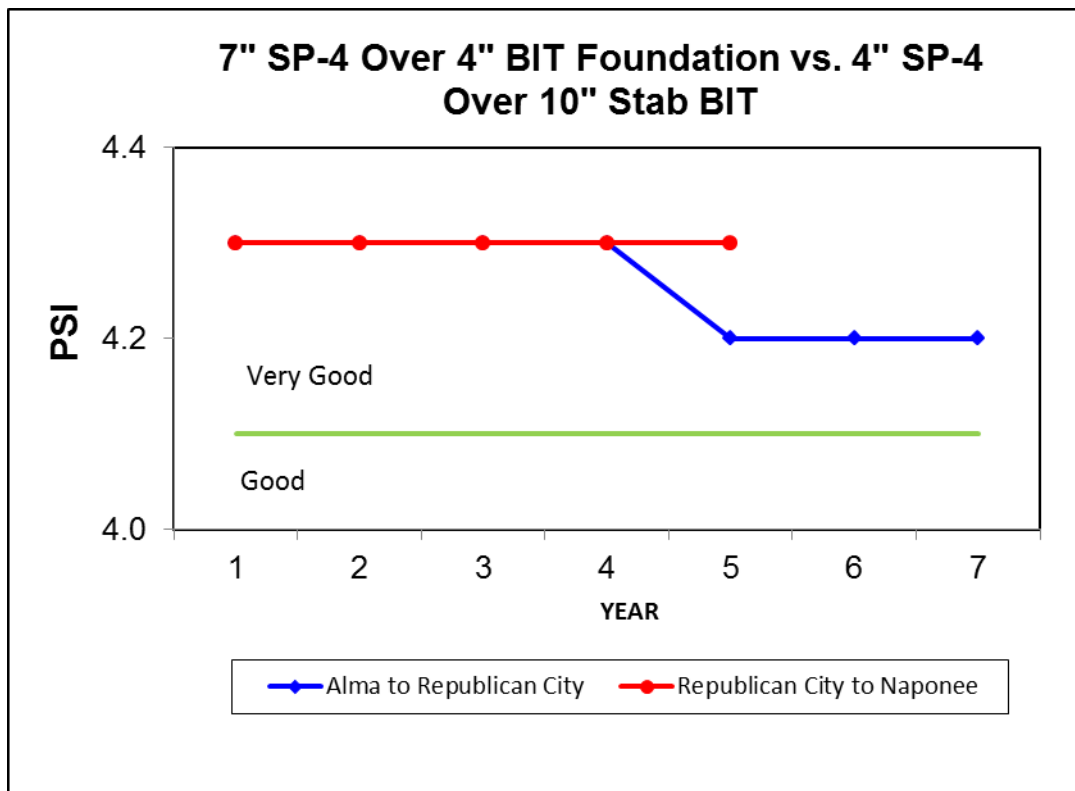
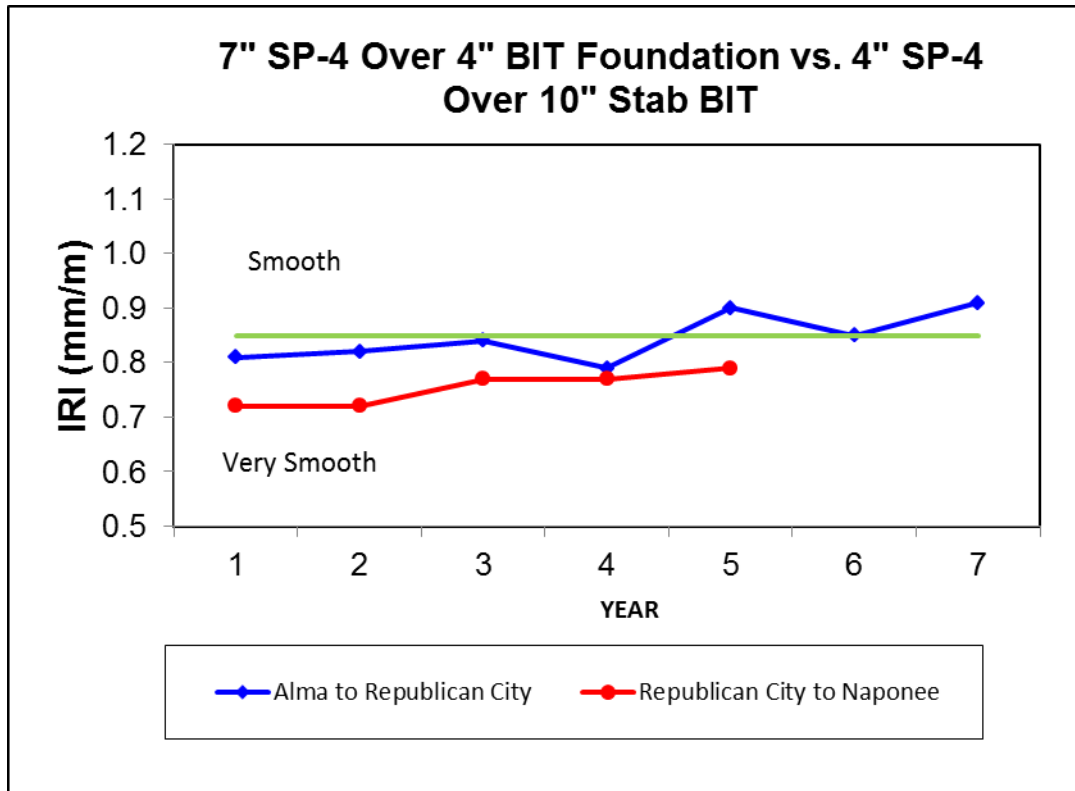


Summary: The experimental doweled-PCC section (Berwyn to Ansley) is outperforming the non-doweled section (Ansley to Mason City) with regard to all parameters. NSI, IRI, PSI, slab distress and faulting in the experimental section have remained consistently superior to those parameters in the conventional pavement throughout the study period. The conventional pavement's slab distress doubled (from ~25% to 50%) between years 7 and 8. Faulting in the two sections was similar during the first six years, but in year 7 the conventional pavement began exhibiting significant increases. Doweled pavement (Berwyn to Ansley) continues to perform better than conventional (non-doweled) pavement with regard to all measured parameters.

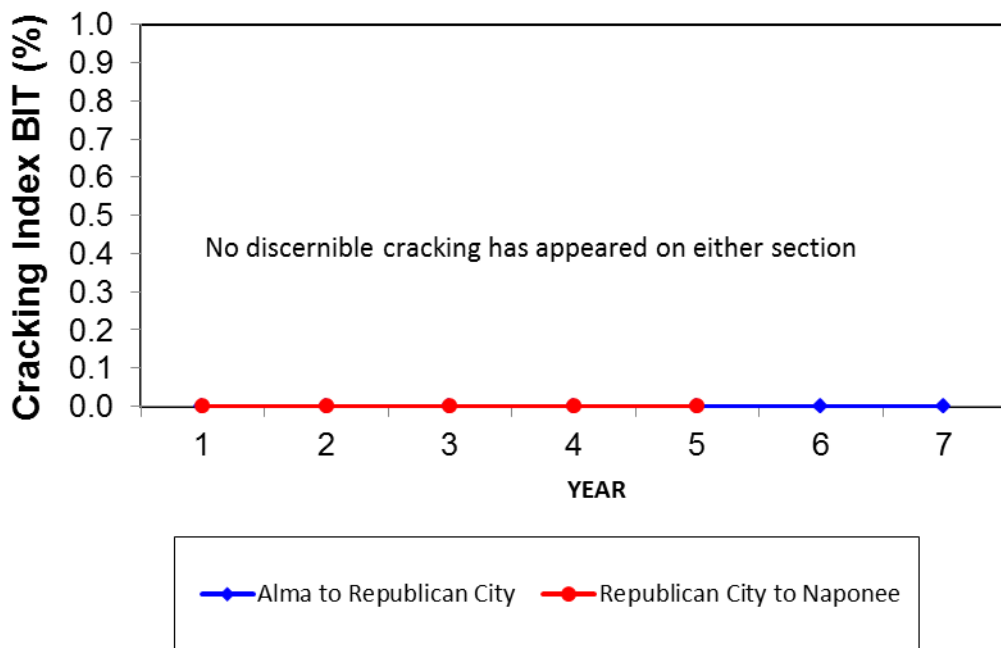
Alma to Republican City vs. Republican City to Naponee

Comparison 4	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Alma to Republican City	7	136	70591	29.56-37.50	7" of SP-4 over 4" bituminous foundation course	
Conventional	Republican City to Naponee	5	136	70591 A	37.50-41.59	4" of SP-4 over 10" FA stab bit (small section of 10" SP-4 on prepared subgrade)	

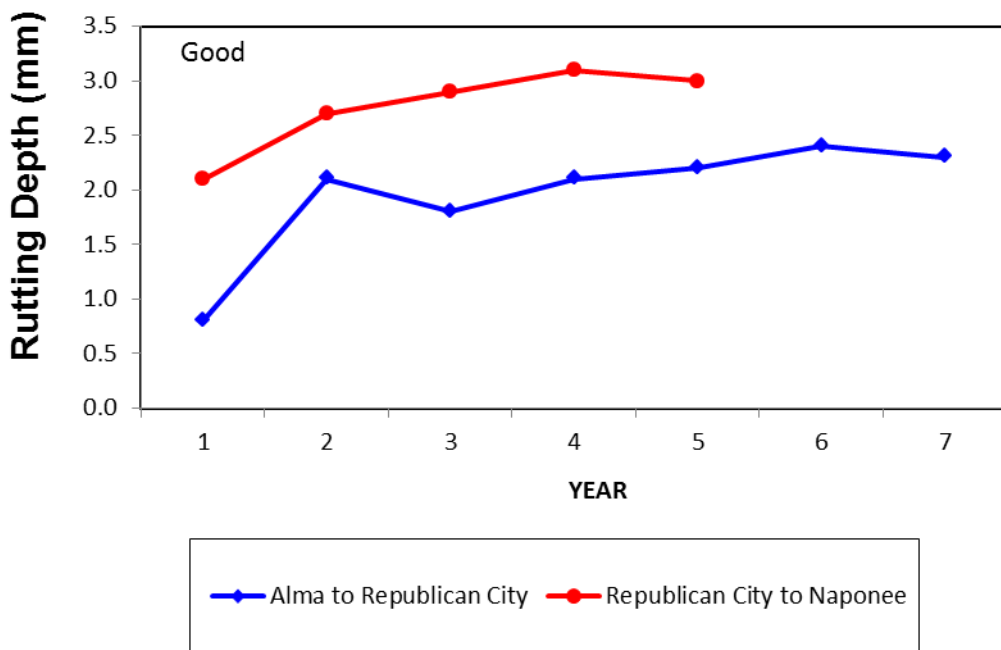




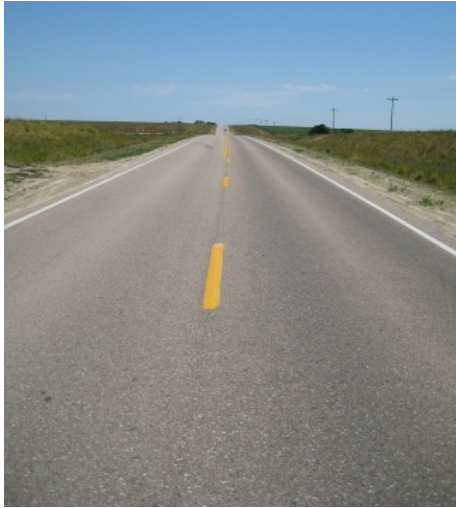
7" SP-4 Over 4" BIT Foundation vs. 4" SP-4 Over 10" Stab BIT



7" SP-4 Over 4" BIT Foundation vs. 4" SP-4 Over 10" Stab BIT



Alma to Republican City (Experimental)



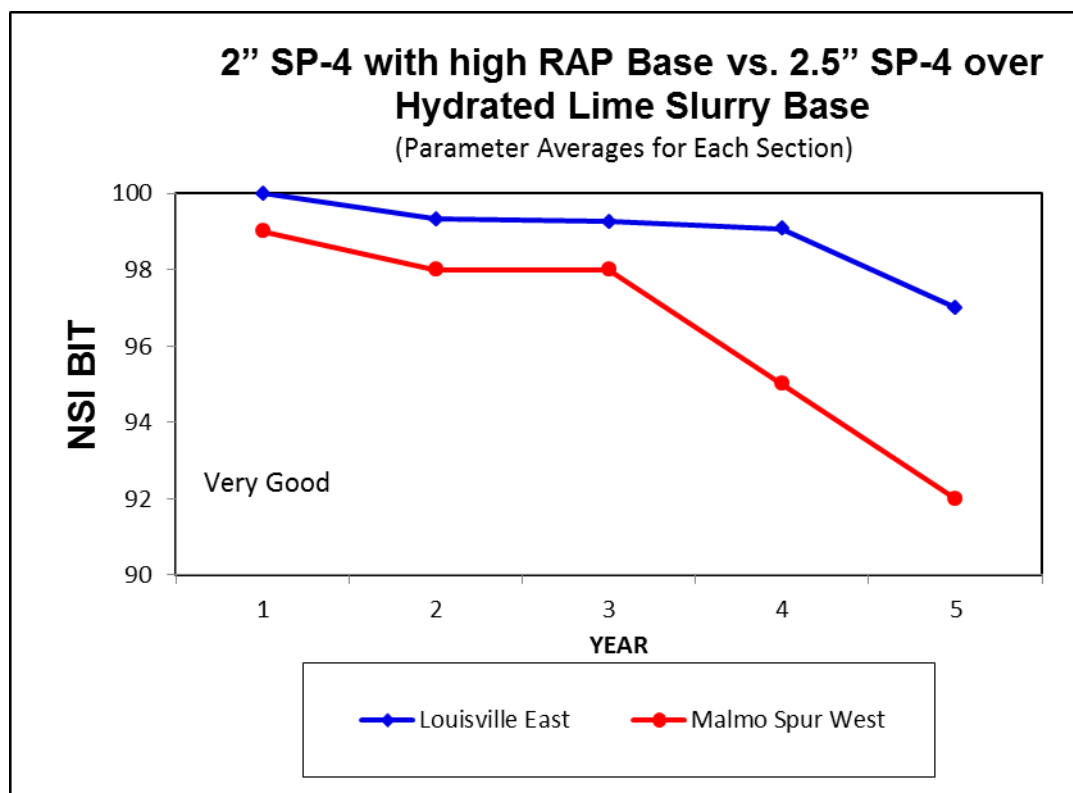
Republican City to Naponee (Conventional)



Summary: The experimental section (Alma to Republican City) and the conventional section (Republican City to Naponee) have exhibited similar NSI over the study period. The age rule caused NSI to drop significantly (from 98 to 92) between year 6 and year 7 on the experimental section. The conventional section will not reach year 6 until next year. The conventional section has outperformed or equaled the performance of the experimental section with regard to IRI every year. The PSI of the experimental section dropped from 4.3 to 4.2 between years 4 and 5 and has consistently remained lower since that time. No cracking has appeared on either section to date. The experimental section has performed better than the conventional with respect to rutting each year of the study. In summary, the conventional section exhibits slightly better performance with regard to PSI and IRI, while the three other parameters appear inconclusive. Neither section has exhibited performance that is clearly superior to its counterpart.

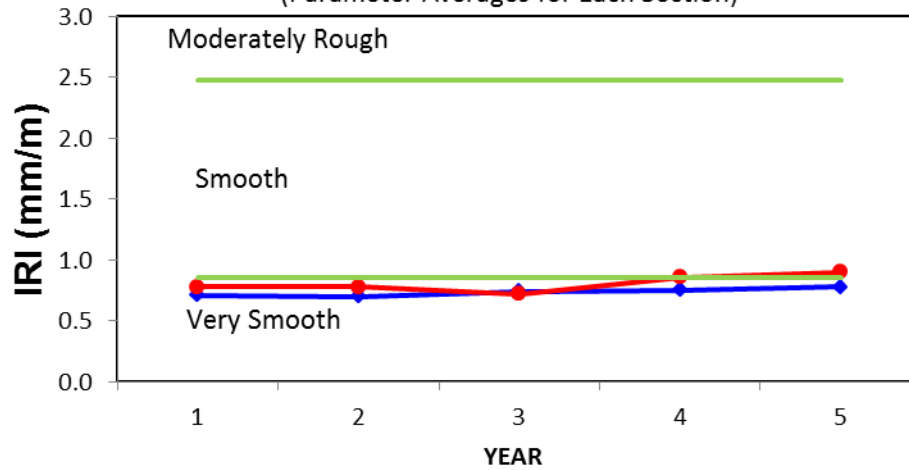
Louisville East to Plattsmouth West vs. Malmo Spur West

Comparison 5	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Louisville East Plattsmouth West	5	66 66	22204 22225	112.07-118.50 118.50-124.84	2" SP-4, 3 3/4" High RAP Base	
Conventional	Malmo Spur West	5	79 & 92	12819	N-79: 22.48- 23.50 N-92: 437.75- 442.77	2.5" of SP-4 over 4" Hyd Lime Slurry Stab base	



2" SP-4 with high RAP Base vs. 2.5" SP-4 over Hydrated Lime Slurry Base

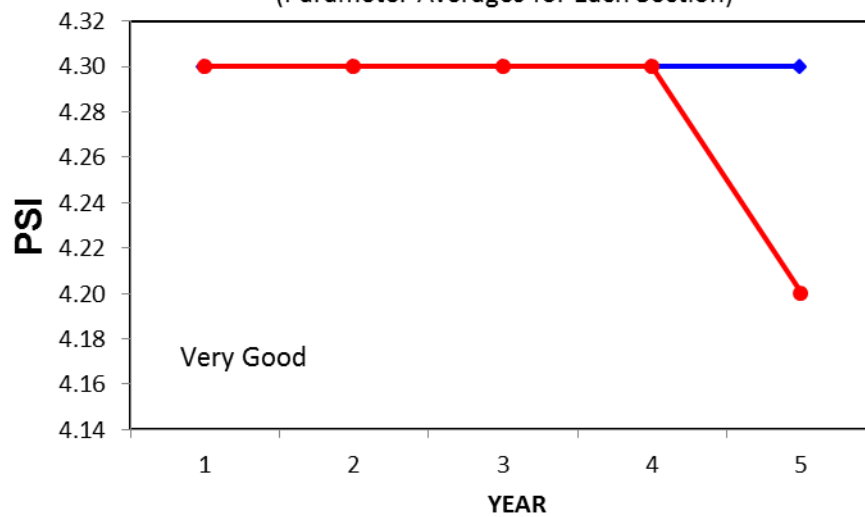
(Parameter Averages for Each Section)



—◆— Louisville East —●— Malmo Spur West

2" SP-4 with high RAP Base vs. 2.5" SP-4 over Hydrated Lime Slurry Base

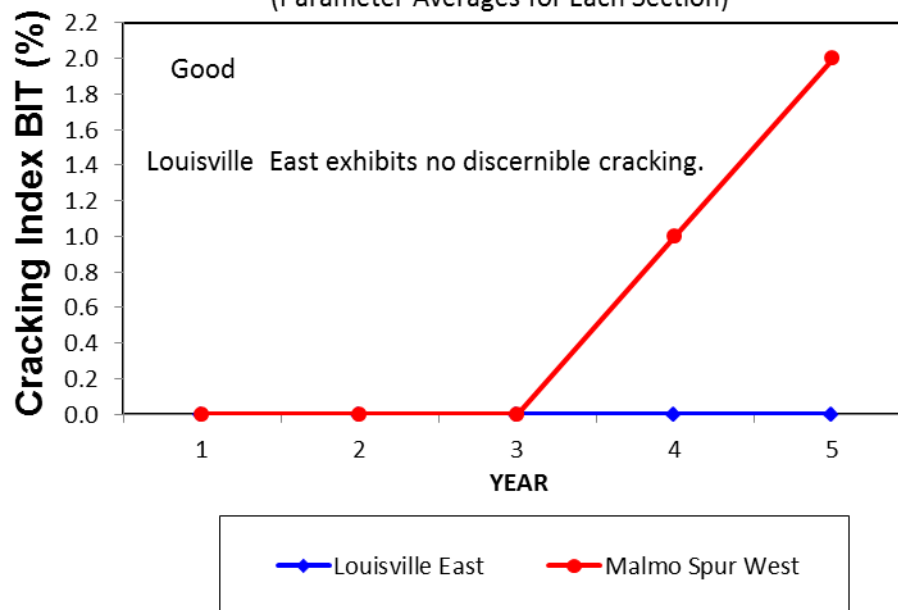
(Parameter Averages for Each Section)



—◆— Louisville East —●— Malmo Spur West

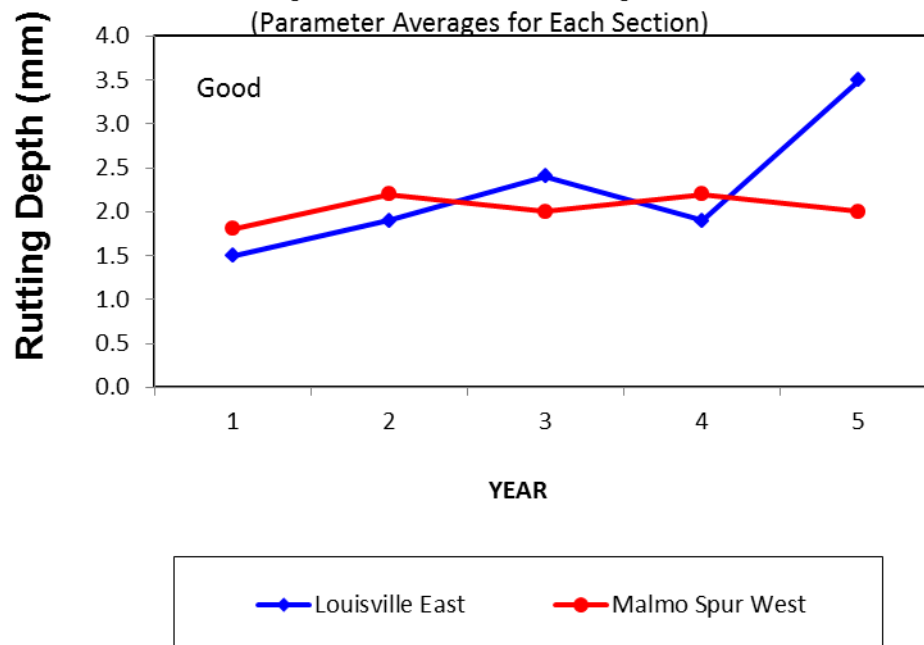
2" SP-4 with high RAP Base vs. 2.5" SP-4 over Hydrated Lime Slurry Base

(Parameter Averages for Each Section)



2" SP-4 with high RAP Base vs. 2.5" SP-4 over Hydrated Lime Slurry Base

(Parameter Averages for Each Section)



Louisville East to Plattsmouth West (Experimental)



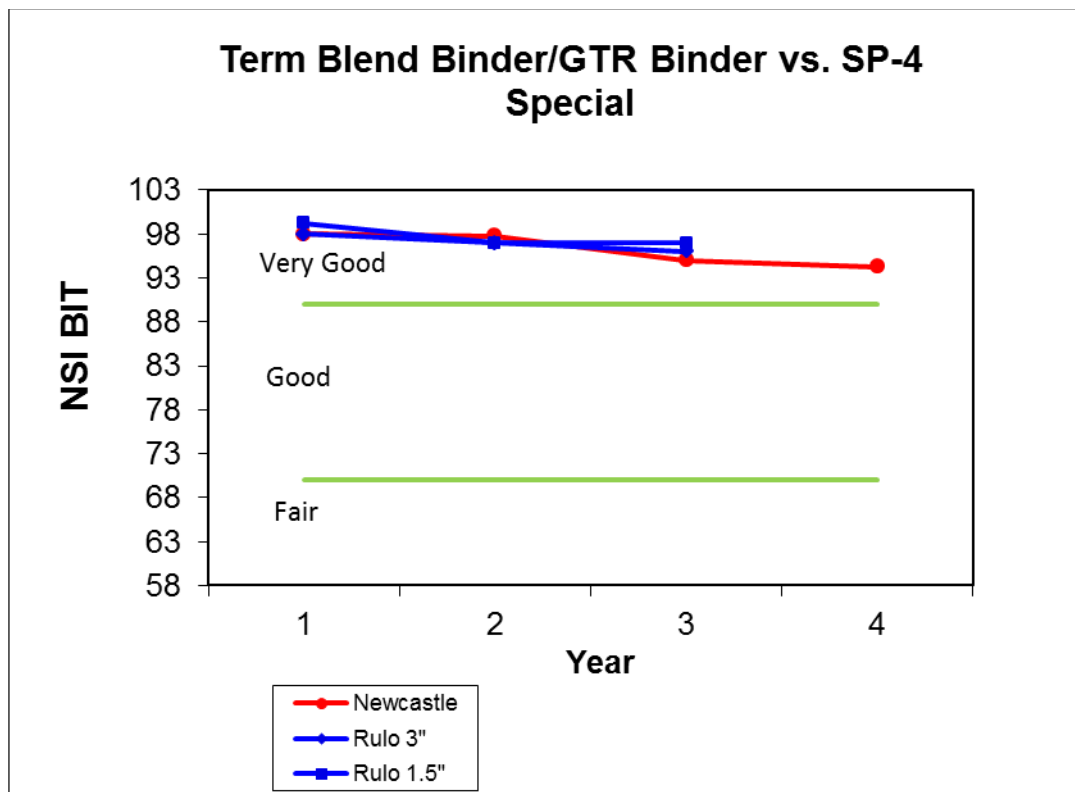
Malmo Spur West (Conventional)



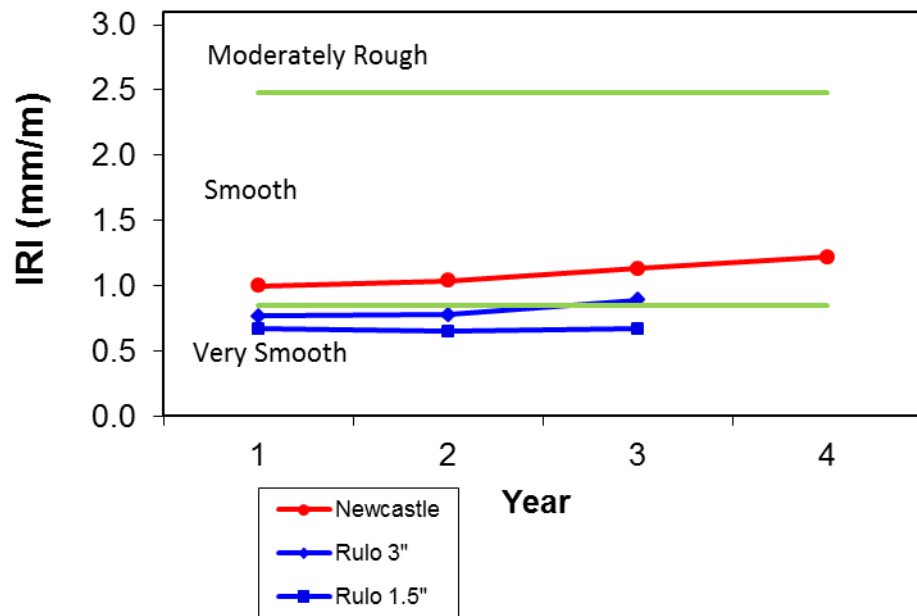
Summary: The experimental section (Louisville East-Plattsmouth West) has outperformed the conventional section (Malmo Spur West) with regard to NSI every year of this study. The IRI of the two sections has remained almost identical over the past five years. Malmo Spur West showed a decrease in PSI beginning one year ago with a corresponding increase in rutting at the same time. Two years ago there was a significant increase in cracking in the conventional section (Malmo Spur West), while the Louisville East-Plattsmouth West section continued to exhibit little to no cracking. If current trends continue, the experimental section will soon be significantly outperforming the conventional section with regard to NSI, PSI and cracking. The other two parameters are inconclusive. Neither section has exhibited performance that is clearly superior to its counterpart.

Rulo West vs. Newcastle

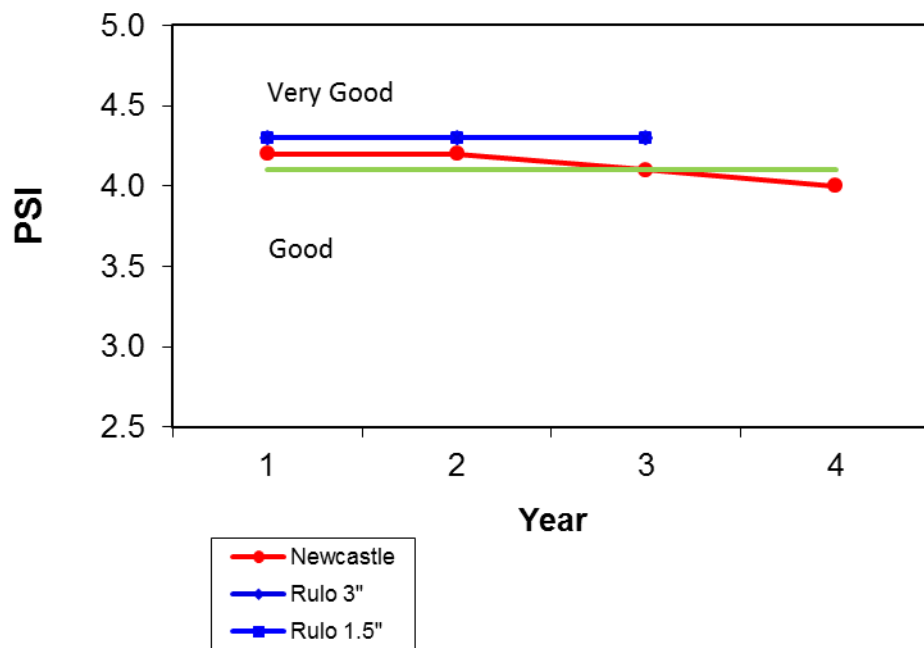
Comparison 6	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Rulo West	3	159	12995	3" : 4.87-5.34, 6.34-11.51, 12.43-13.34/ 1.5" : 5.34-6.34, 11.51-12.43	3" SP-4 (Term Blend CR Binder) Mill 1.5"/Fill 1.5" SP-4 GTR Bind Mill 3"/Fill 3" SP-4 GTR Binder	
Conventional	Newcastle	4	12	31798	222.25-233.96	Mill 2-3"/Fill 3" SP-4 Special	



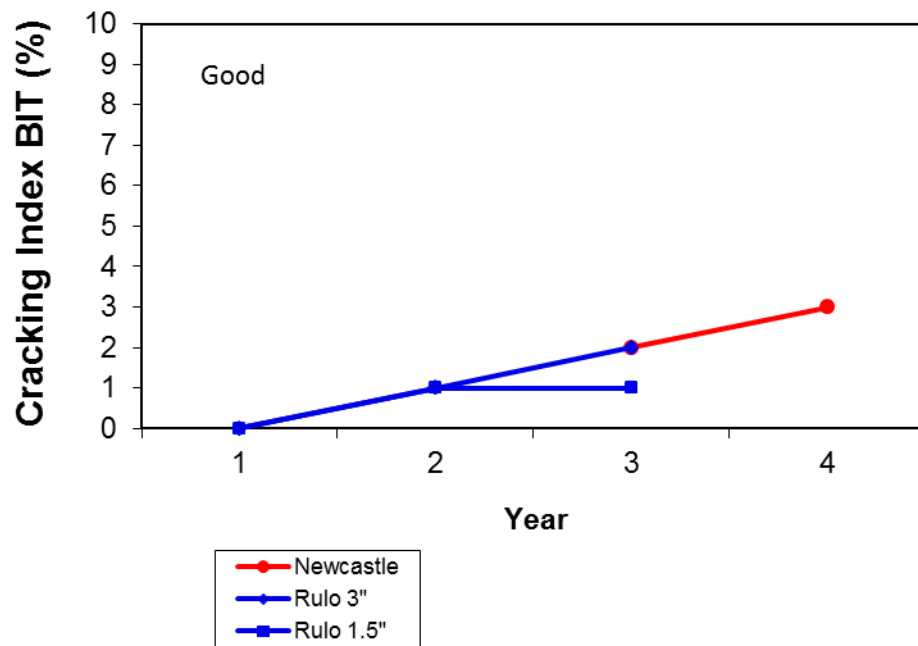
Term Blend Binder/GTR Binder vs. SP-4 Special



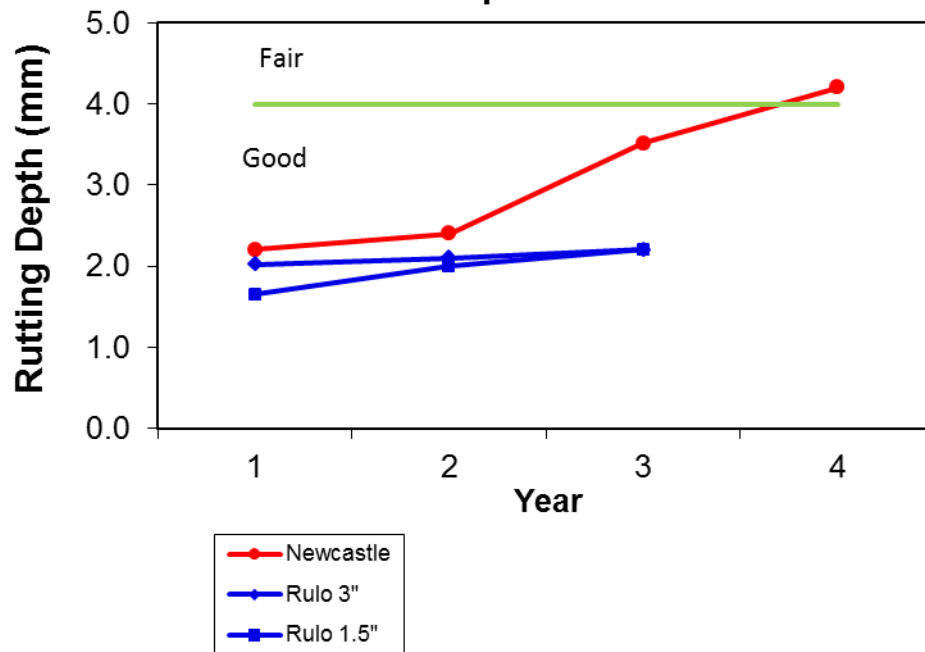
Term Blend Binder/GTR Binder vs. SP-4 Special



Term Blend Binder/GTR Binder vs. SP-4 Special



Term Blend Binder/GTR Binder vs. SP-4 Special



Rulo West (Experimental)



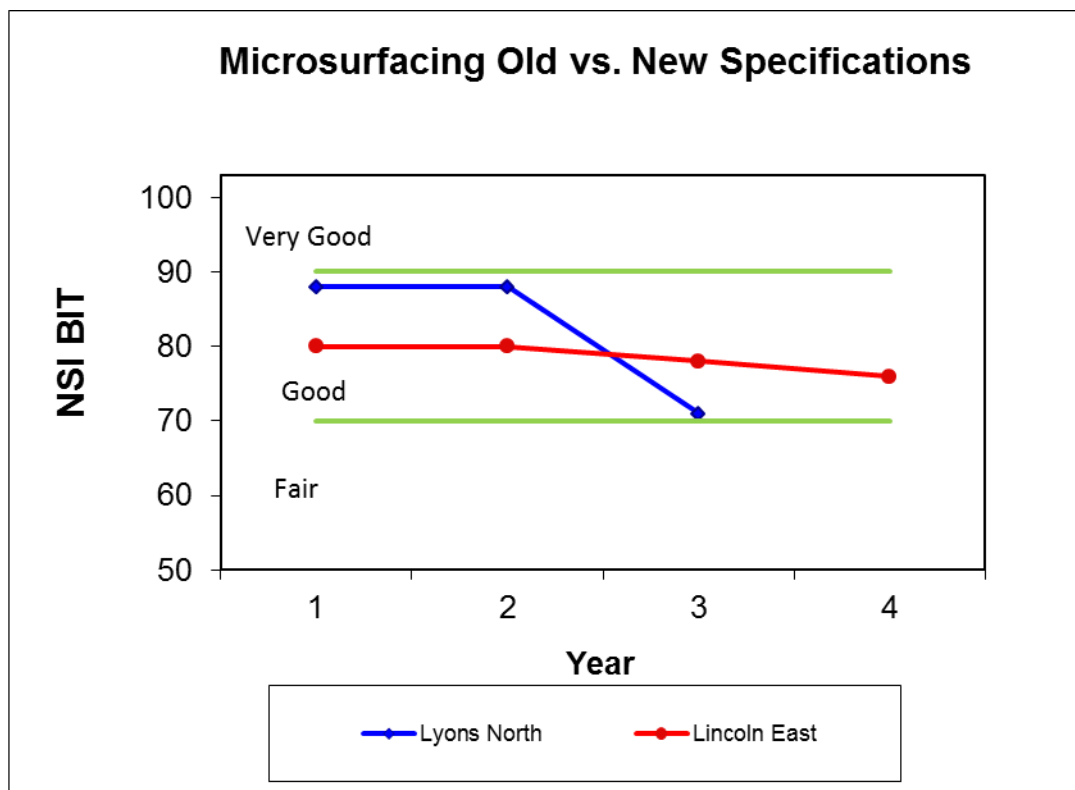
Newcastle (Conventional)



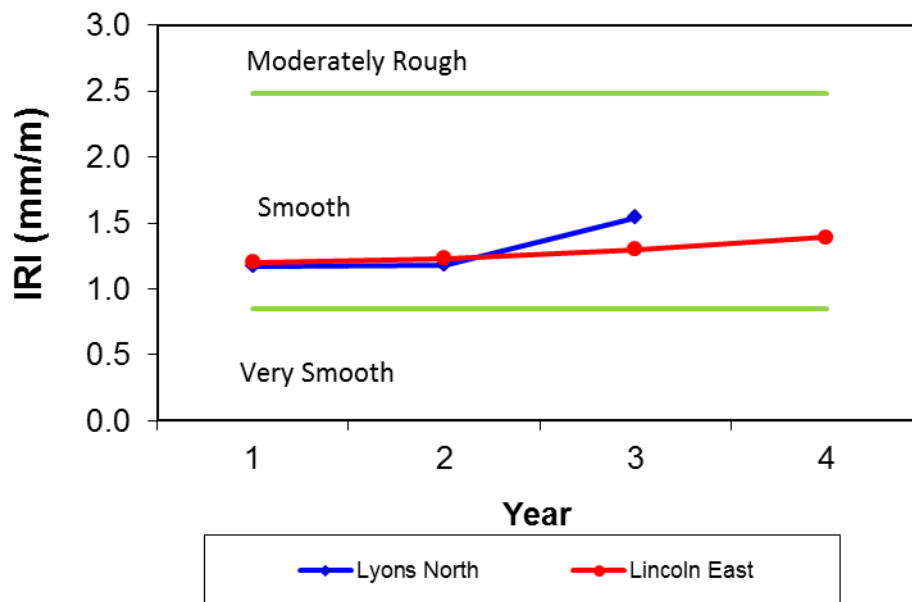
Summary: The experimental section (Rulo West) and the convention section (Newcastle) exhibited similar results for NSI and cracking during the first three years of pavement life. The experimental section outperformed the conventional section slightly with regard to IRI and PSI. Rutting depth in the conventional pavement is almost twice that in the experimental pavement after three years and exceeded four millimeters between years 3 and 4. The experimental section appears to be performing better in three of the five measured parameters (IRI, PSI and rutting), but these trends are preliminary, as pavement life is only three and four years respectively.

Lyons North vs. Lincoln East

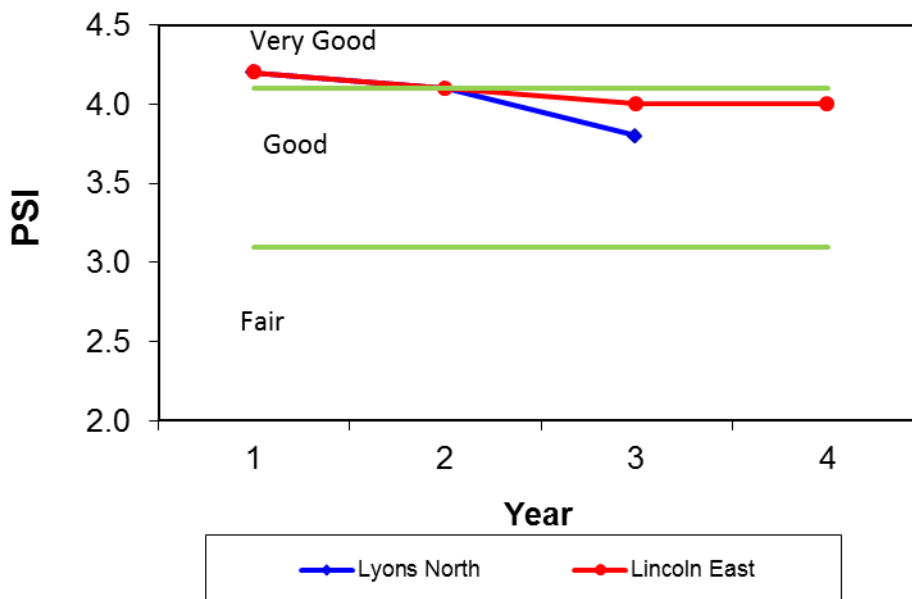
<i>Comparison 7</i>	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Lyons North	3	77	3197 4	148.77- 163.91	Microsurfacing (new spec.)	
Conventional	Lincoln East	4	34	1990 8C	332.64- 341.48	Microsurfacing (old spec.)	



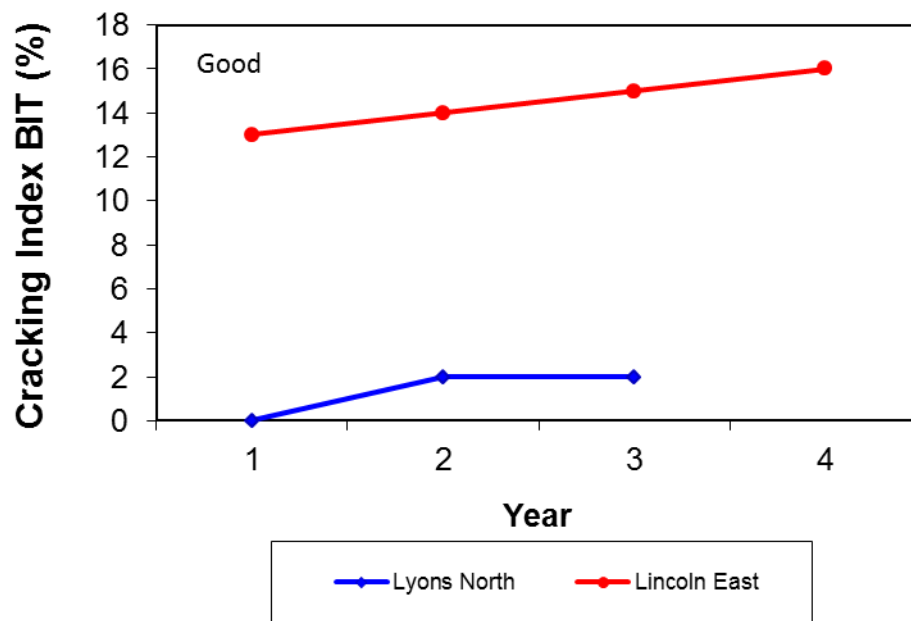
Microsurfacing Old vs. New Specifications



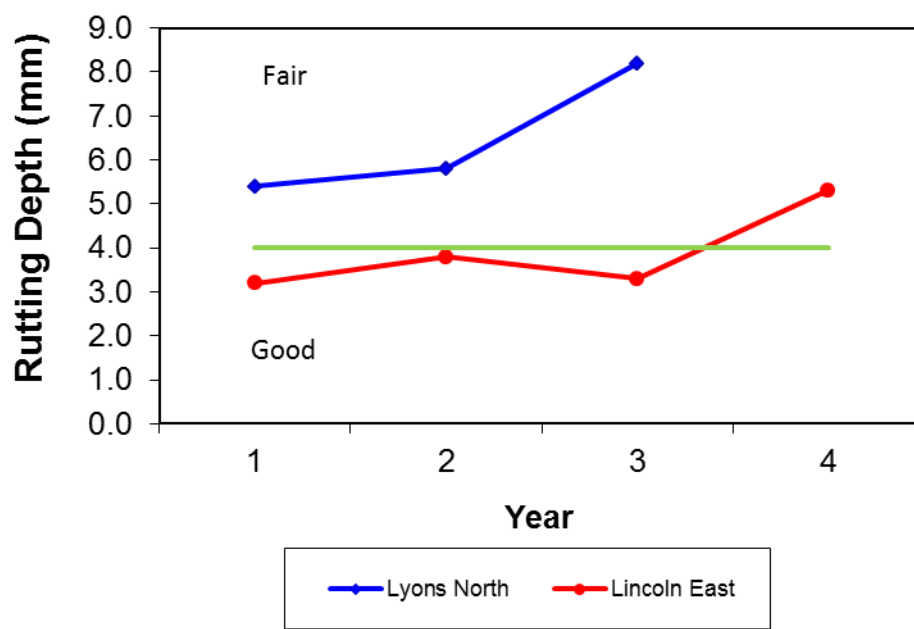
Microsurfacing Old vs. New Specifications



Microsurfacing Old vs. New Specifications



Microsurfacing Old vs. New Specifications



Lyons North (Experimental)



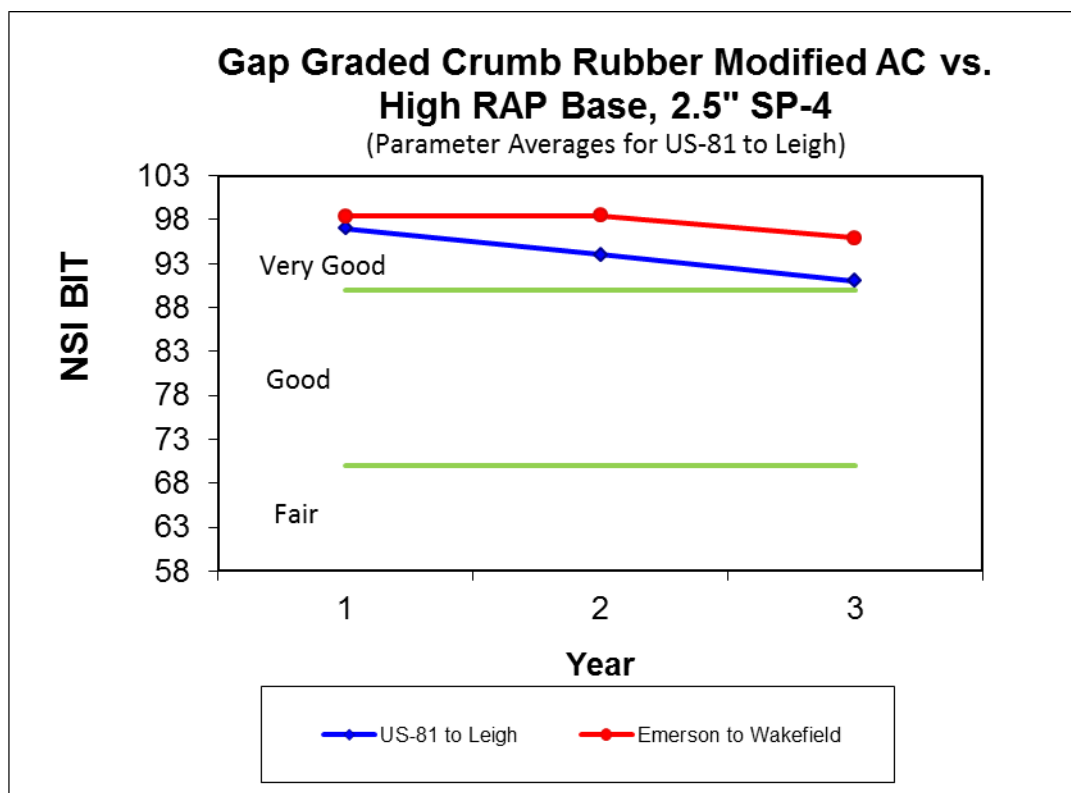
Lincoln East (Conventional)



Summary: The experimental section (Lyons North) outperformed the conventional section (Lincoln East) with regard to NSI during the first two years of this study. Between years 2 and 3, rutting increased from 6 mm to slightly more than 8 mm, which resulted in the NSI decreasing to 71. The conventional section is now performing better than the experimental section with regard to NSI. Performance with regard to IRI and PSI was similar through year 2, but in year 3 IRI increased in the experimental section, resulting in a decrease in PSI. Conventional pavement appears to be performing in a superior manner with regard to IRI and PSI at present. The experimental section has exhibited less cracking but significantly deeper rutting compared to the same parameters in the conventional section. Conventional pavement is currently performing in a superior manner with regard to all measured parameters except cracking. These trends are preliminary, as pavement life is only three and four years respectively.

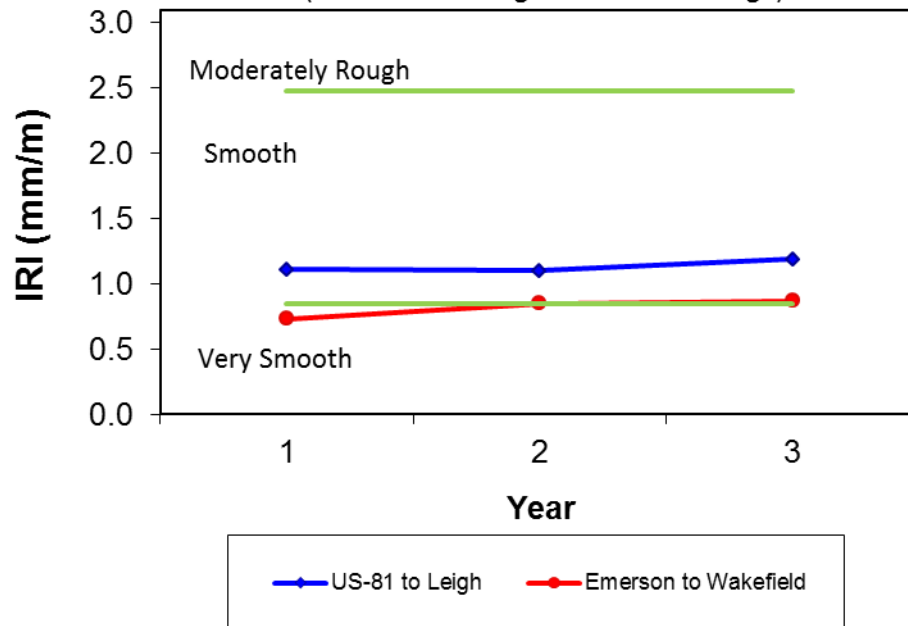
US-81 to Leigh vs. Emerson to N. of Wakefield

Comparison 8	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	US-81 to Leigh	3	91	31899	153.53-163.98 & 164.67-165.33	Mill 4"/Fill 4" High RAP Base. 2" Gap Graded Crumb Rubber Modified AC	
Conventional	Emerson to N. of Wakefield	3	9	31877	30.53-37.38	Mill 4"/Fill 4" HRB 2 1/2" SP4	



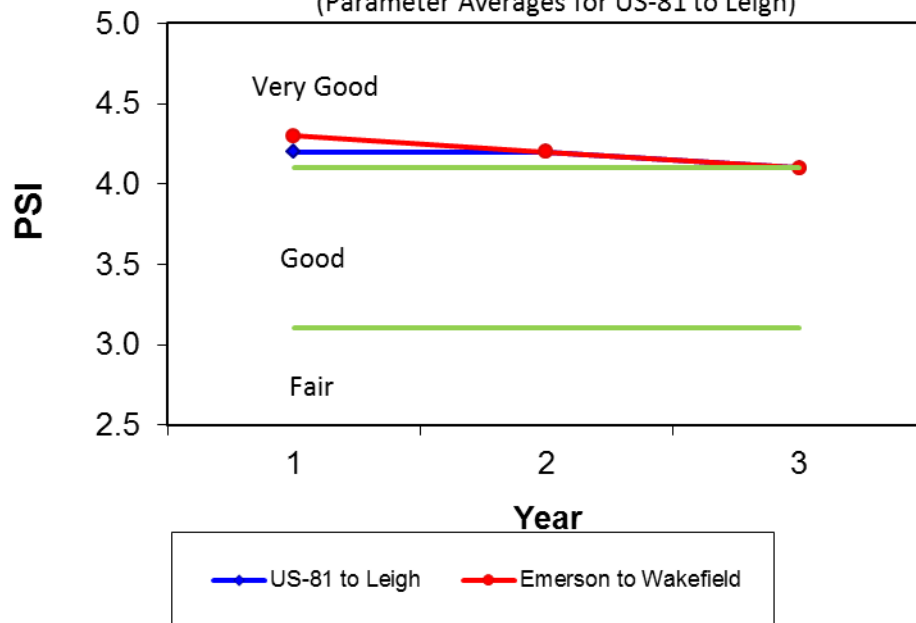
Gap Graded Crumb Rubber Modified AC vs. High RAP Base, 2.5" SP-4

(Parameter Averages for US-81 to Leigh)



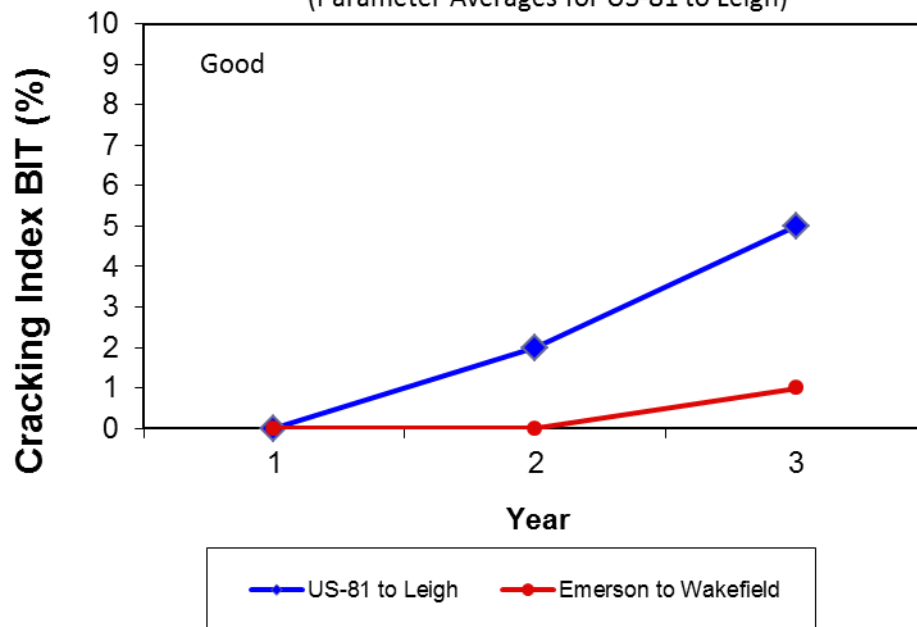
Gap Graded Crumb Rubber Modified AC vs. High RAP Base, 2.5" SP-4

(Parameter Averages for US-81 to Leigh)



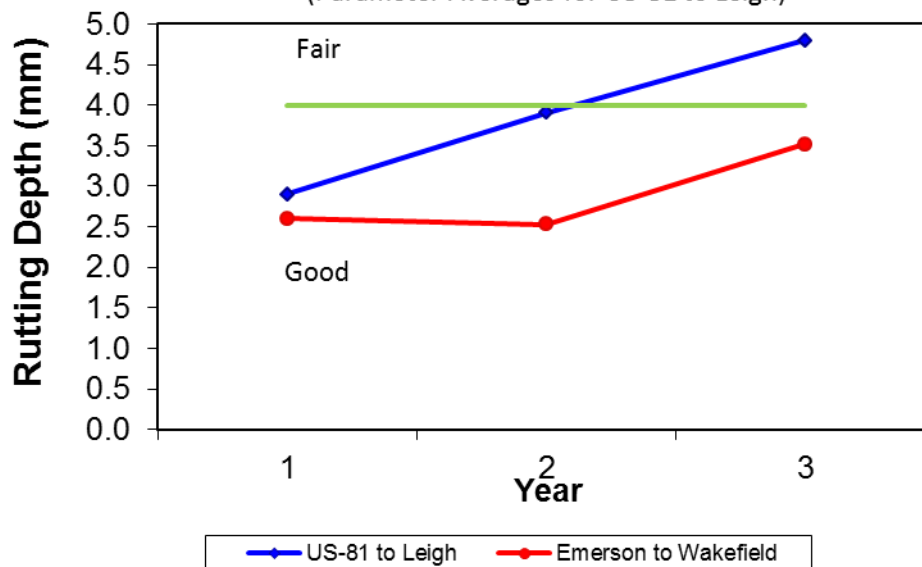
Gap Graded Crumb Rubber Modified AC vs. High RAP Base, 2.5" SP-4

(Parameter Averages for US-81 to Leigh)



Gap Graded Crumb Rubber Modified AC vs. High RAP Base, 2.5" SP-4

(Parameter Averages for US-81 to Leigh)



US-81 to Leigh (Experimental)



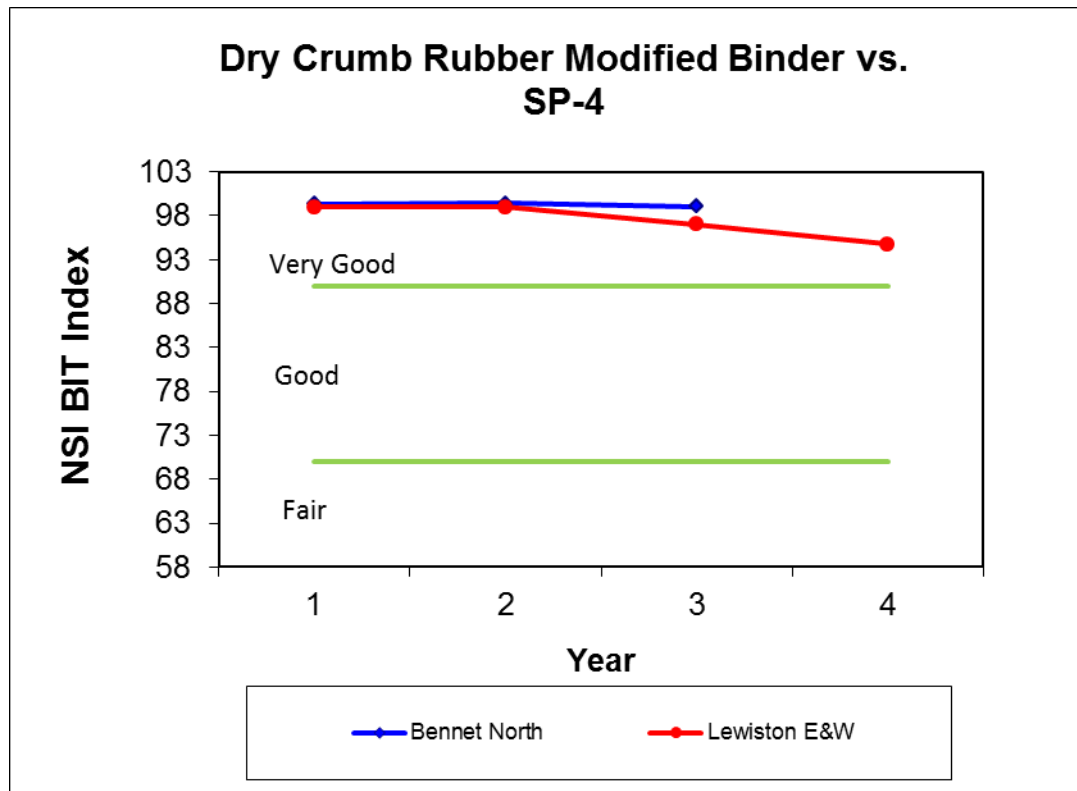
Emerson to N. of Wakefield (Conventional)



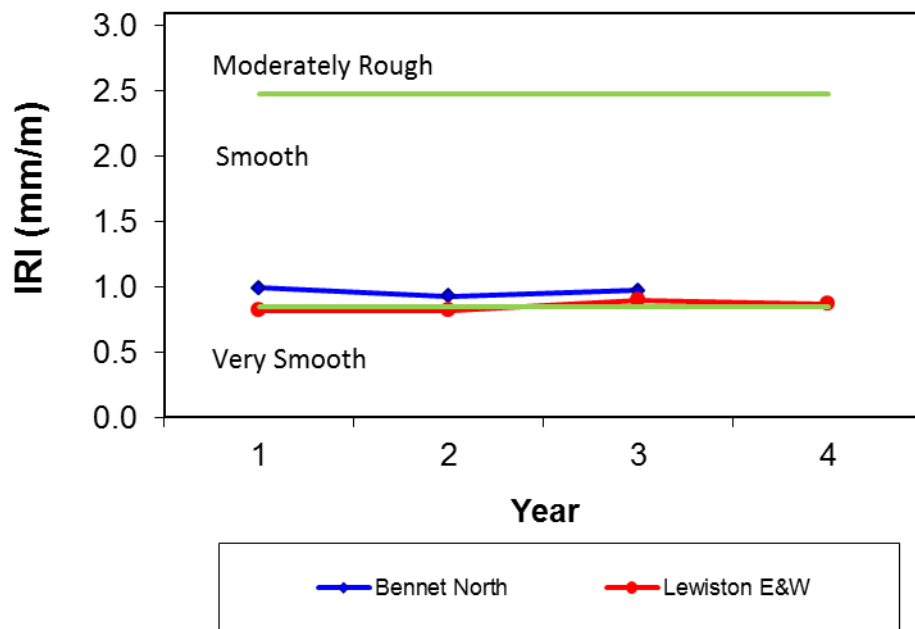
Summary: The conventional HRB SP-4 pavement (Emerson to North of Wakefield) is outperforming the experimental high RAP base GGCRM pavement (US-81 to Leigh) with regard to NSI, IRI, cracking and rutting. After three years, measurements for PSI remain nearly identical. However, NSI is higher, IRI is lower, cracking is much more prevalent and rutting is deeper in the experimental section based upon the data collected. Data collected extends only through the third year, so indications of long-term trends are somewhat tentative. Collection of future data will assist in determining if the conventional section continues to perform in a superior manner.

Bennet North vs. Lewiston E & W

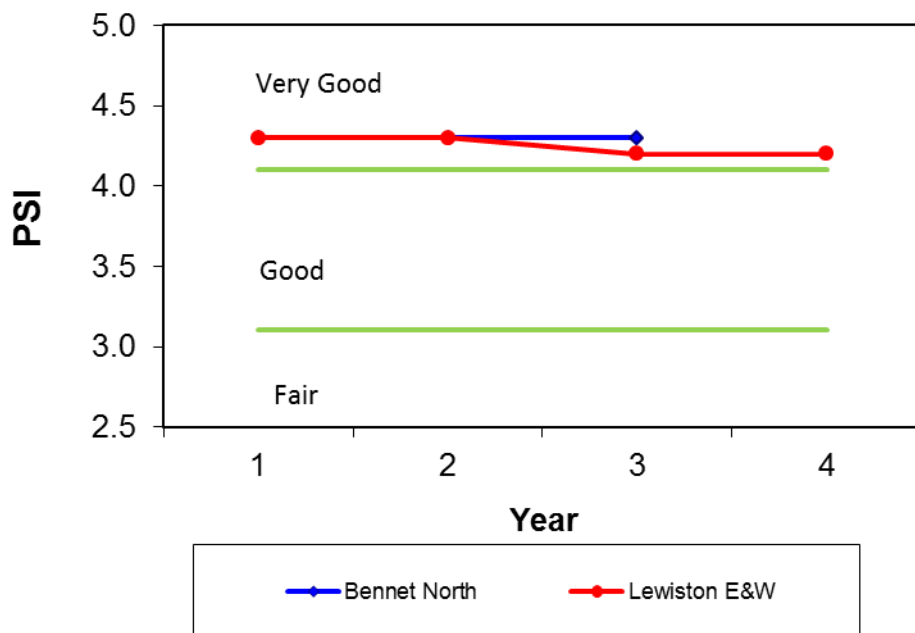
Comparison 9	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Bennet North	3	43	130 17	15.46- 16.74	Mill 2"/Fill 2" SP-4 w/Dry Crumb Rubber Modified Binder	
Conventional	Lewiston E&W	4	4	128 21	167.47- 179.55	Mill 2"/Fill 2" SP-4 Special	



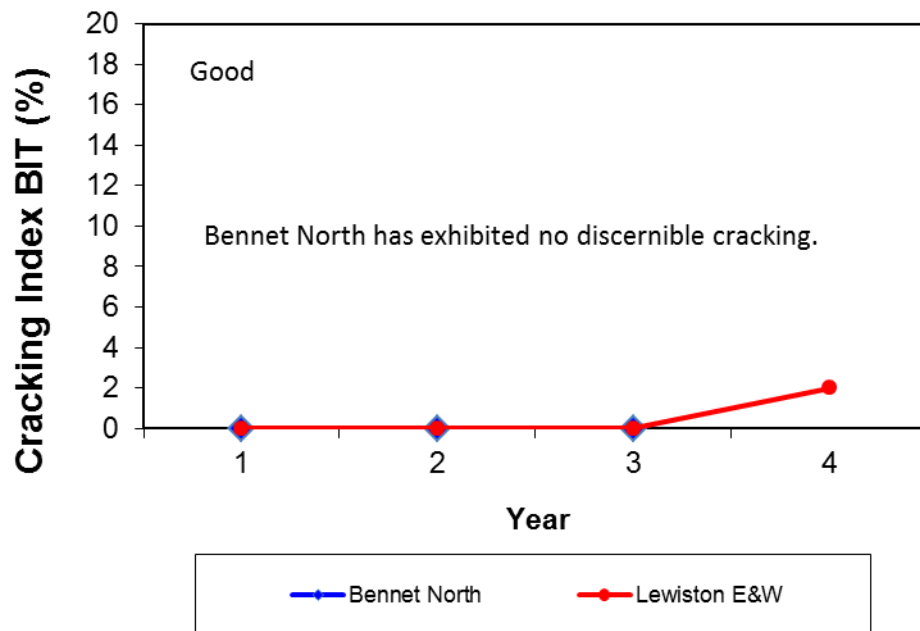
Dry Crumb Rubber Modified Binder vs. SP-4



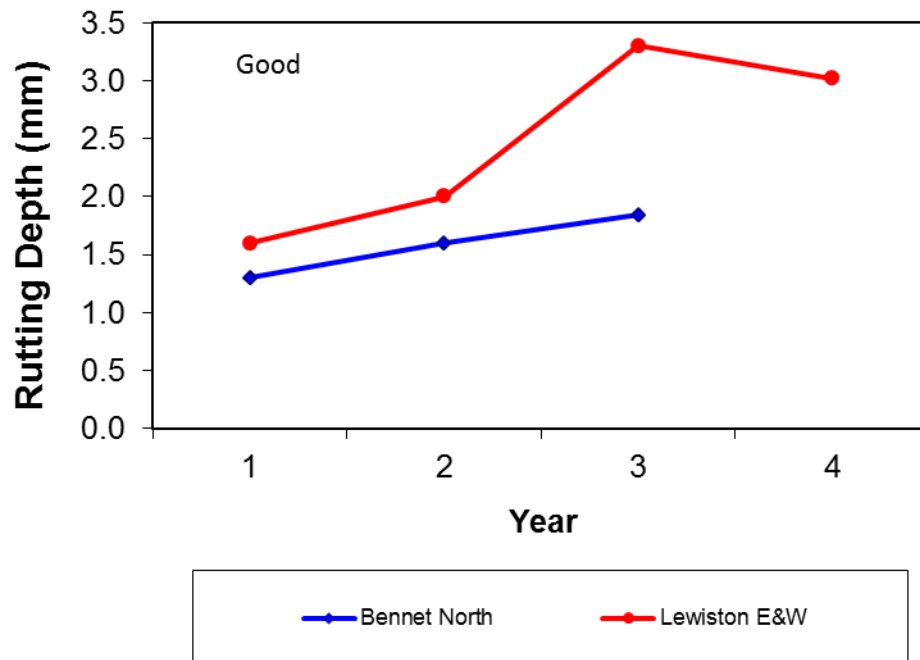
Dry Crumb Rubber Modified Binder vs. SP-4



Dry Crumb Rubber Modified Binder vs. SP-4



Dry Crumb Rubber Modified Binder vs. SP-4



Bennet North (Experimental)



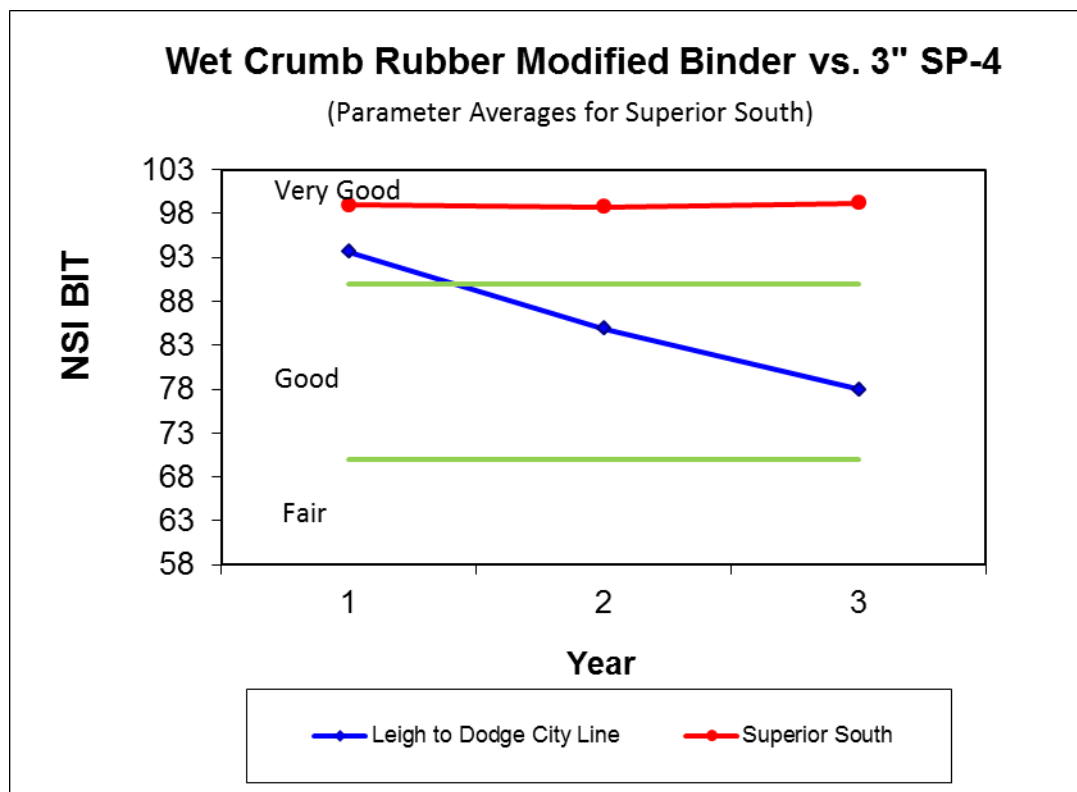
Lewiston E & W (Conventional)



Summary: The experimental section (Bennet North) and the conventional SP-4 section (Lewiston E & W) have performed in a similar manner with regard to NSI and PSI. NSI and PSI in the conventional section began to decline between years 2 and 3, so the experimental section is now performing slightly better with regard to these parameters. IRI has remained slightly higher on the experimental section each year. No cracking has been observed on either section with the exception of minor instances on Lewiston E & W in year 4. The experimental section has consistently outperformed the conventional pavement with regard to rutting, exhibiting less than half the rutting of its counterpart in year 3. Data collected extends only through the third and fourth year, so indications of long-term trends are somewhat tentative. Bennett North is showing indications of outperforming Lewiston E & W with regard to three of the five measured parameters (NSI, PSI, and rutting). Collection of future data will assist in determining if the indicated trends continue.

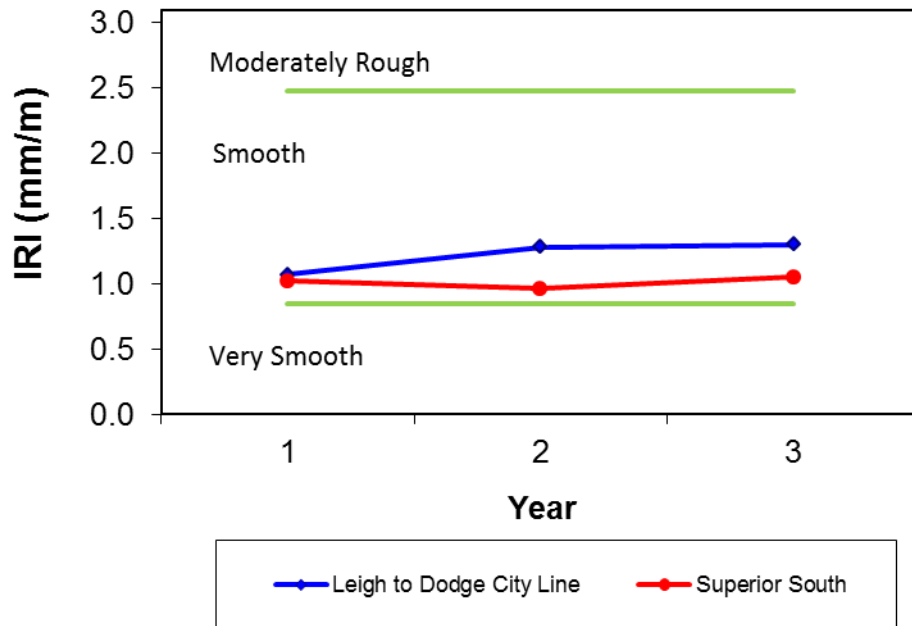
Leigh to Dodge County Line vs. Superior South

Comparison 10	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Leigh to Dodge Cty Line	3	91	31985	165.33-182.85	Mill 2"/Fill 2" SP-4 w/Wet Crumb Rubber Modified Binder	
Conventional	Superior South	3	14	42544	0.00-1.90, 2.85-7.32	2" SP4, 3" SP4	



Wet Crumb Rubber Modified Binder vs. 3" SP-4

(Parameter Averages for Superior South)



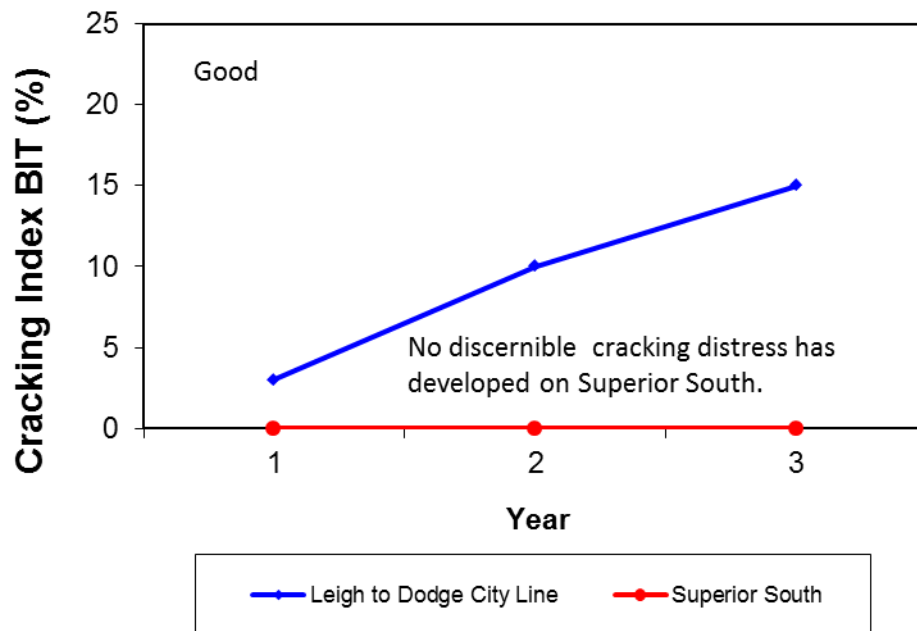
Wet Crumb Rubber Modified Binder vs. 3" SP-4

(Parameter Averages for Superior South)



Wet Crumb Rubber Modified Binder vs. 3" SP-4

(Parameter Averages for Superior South)



Wet Crumb Rubber Modified Binder vs. 3" SP-4

(Parameter Averages for Superior South)



Leigh to Dodge County Line (Experimental)



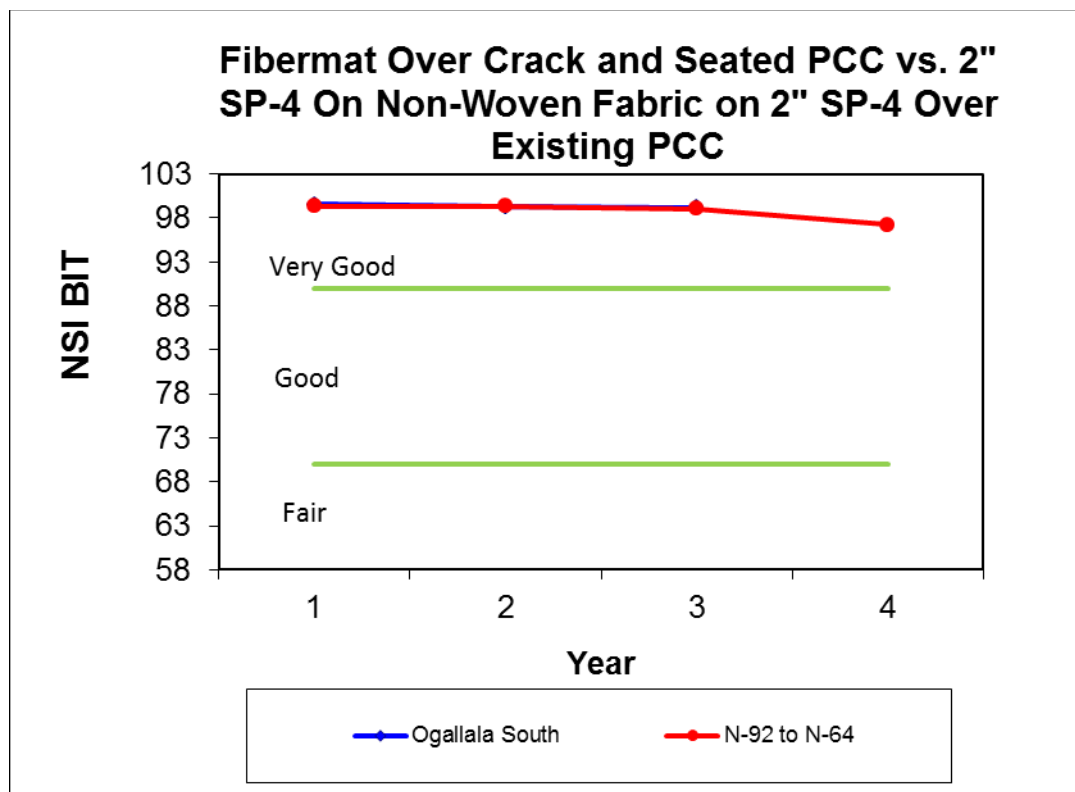
Superior South (Conventional)



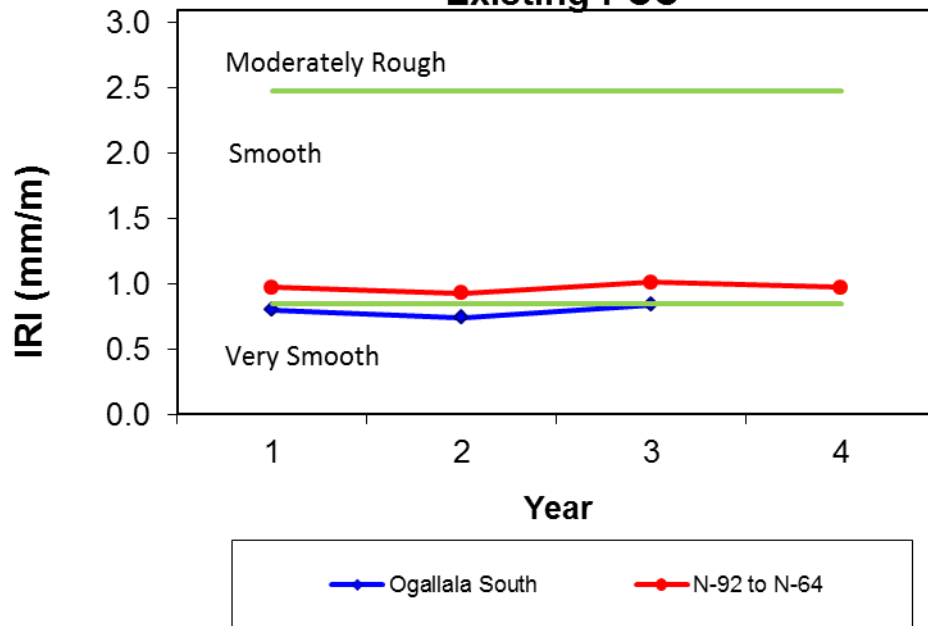
Summary: Conventional SP-4 pavement (Superior South) is outperforming the experimental pavement (Leigh to Dodge County Line) in all five measured parameters at the end of year 3. The Superior South pavement exhibited higher NSI, lower IRI, higher PSI, less cracking and shallower rutting than Leigh to Dodge County Line. During years 1 and 2, Leigh to Dodge County Line exhibited less rutting, but between years 2 and 3 rutting on this section increased until it surpassed that occurring on Superior South. No cracking has been observed on Superior South while an increase in cracking of about five percent per year was noted on Leigh to Dodge County Line. Data collected extends only through year 3, so indications of long-term trends are tentative. However, it appears that Superior South is currently performing better with regard to all parameters. Collection of future data will assist in determining if the indicated trends continue.

Ogallala South vs. N-92 to N-64

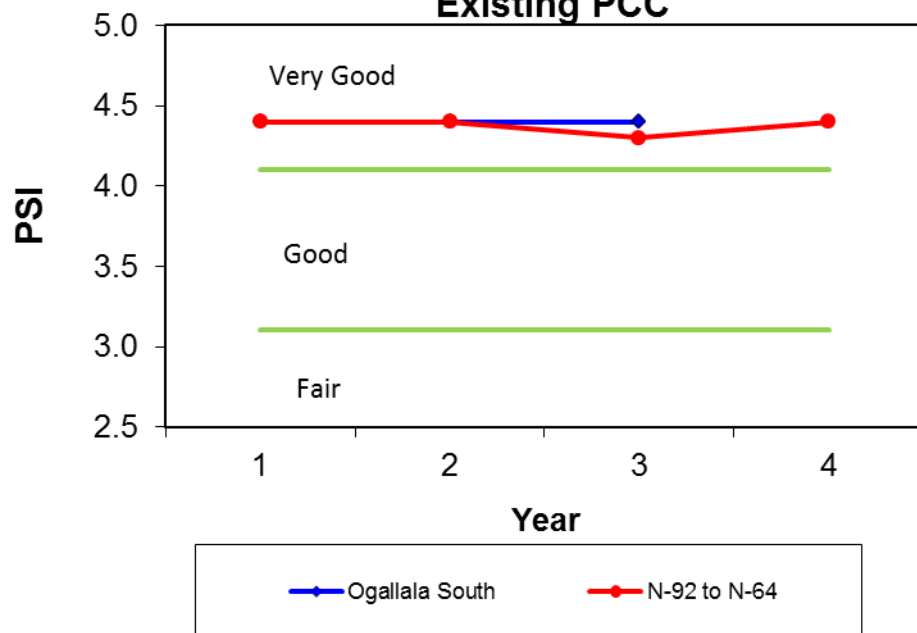
Comparison 11	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Ogallala South	3	61	61436	78.68-81.71 81.71-82.71 82.71-85.21	1.5" SP4 on 1.5" HRB (no Fibermat) 1.5" SP4 on Fibermat on 1.5" HRB 1.5" SP4 on 1.5" HRB on Fibermat	
Conventional	N-92 to N-64	4	81	42440	95.26-104.80	2" SP-4 on non-woven fabric on 2" SP-4 over existing PCC	



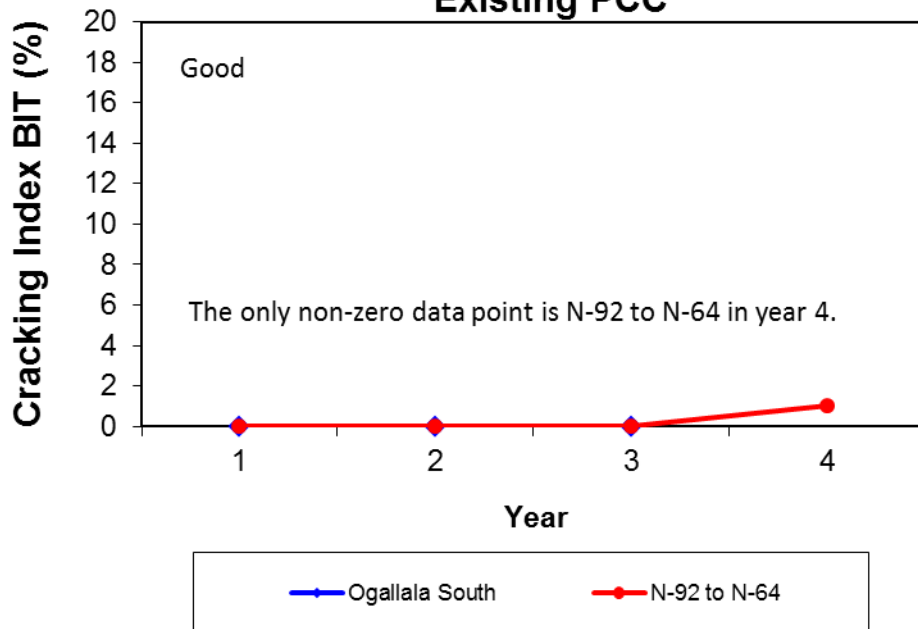
Fibermat Over Crack and Seated PCC vs. 2" SP-4 On Non-Woven Fabric on 2" SP-4 Over Existing PCC



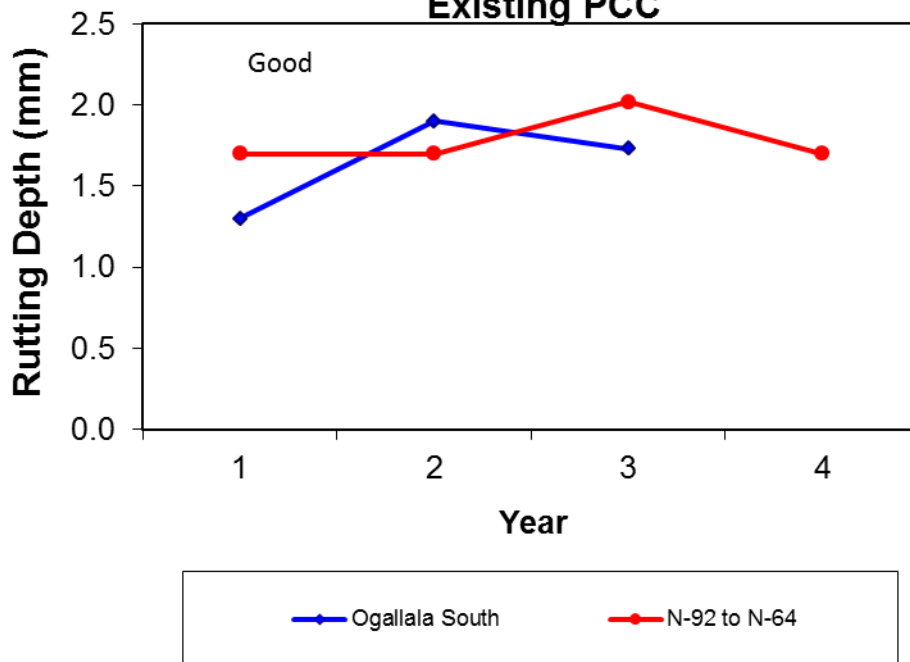
Fibermat Over Crack and Seated PCC vs. 2" SP-4 On Non-Woven Fabric on 2" SP-4 Over Existing PCC



Fibermat Over Crack and Seated PCC vs. 2" SP-4 On Non-Woven Fabric on 2" SP-4 Over Existing PCC



Fibermat Over Crack and Seated PCC vs. 2" SP-4 On Non-Woven Fabric on 2" SP-4 Over Existing PCC



Ogallala South (Experimental)



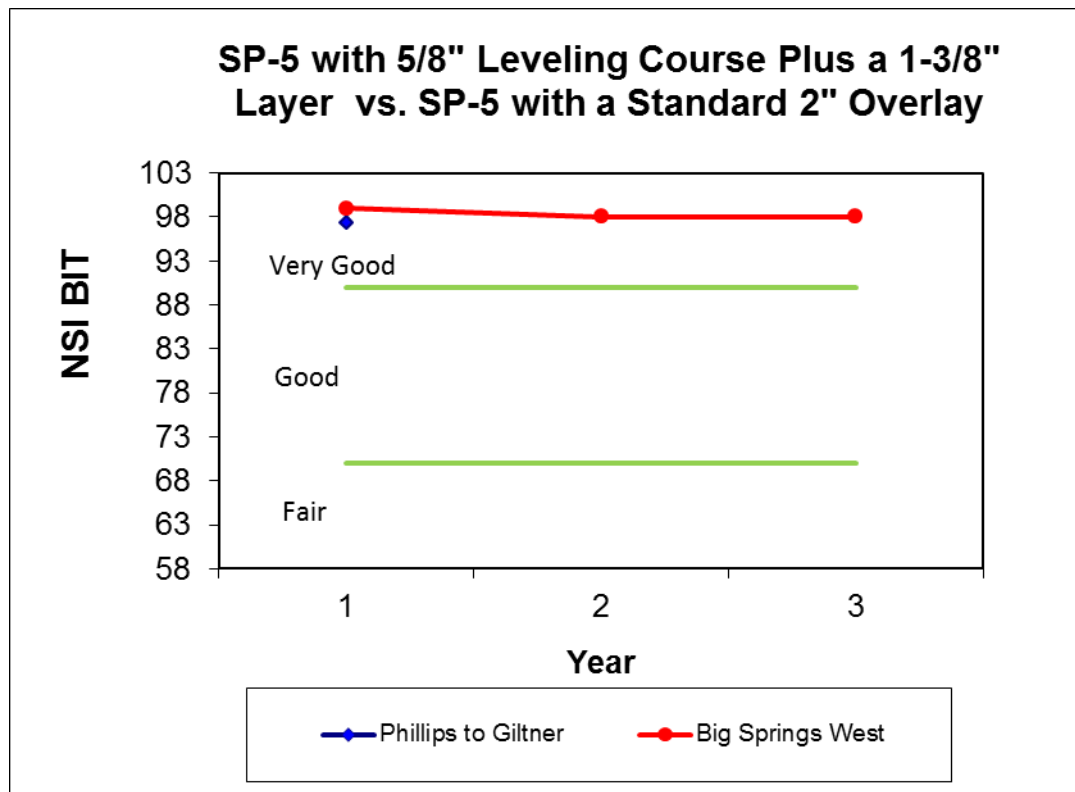
N-92 to N-64 (Conventional)



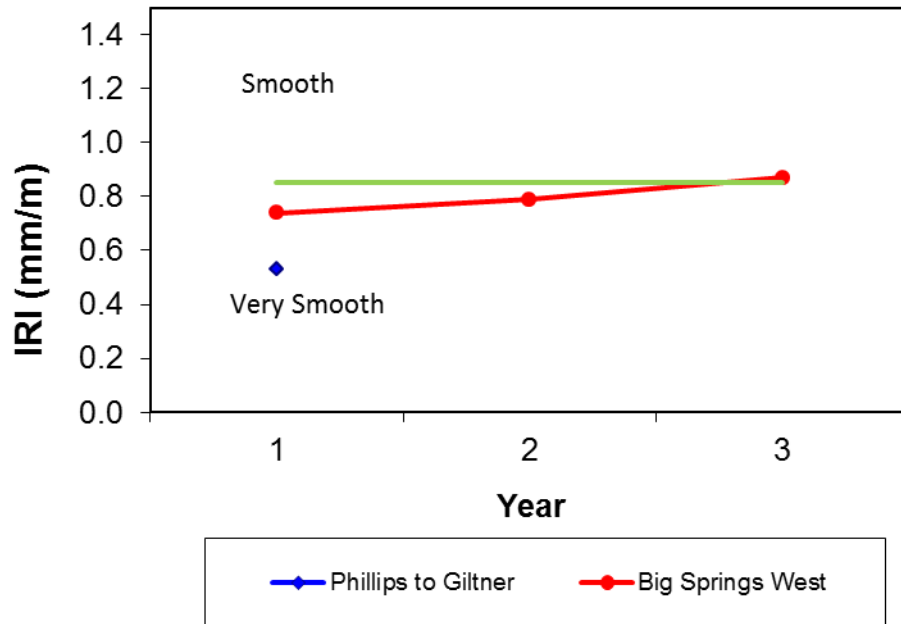
Summary: The experimental pavement (Ogallala South) and the conventional (N-92 to N-64) have performed in a similar manner with regard to four of the five measured parameters during the study period. The NSI of both sections has remained essentially identical. Ogallala South has maintained consistently lower IRI and exhibited slightly higher PSI in the third year. Cracking has not been recorded on either section, with the exception of 2% on N-92 to N-64 in year 4. Rutting depth within both sections has remained within specifications for very good pavement. Data collection extends only through the third and fourth year, so indications of long-term trends are tentative. At present, neither section exhibits performance that is clearly superior to that of its counterpart. Collection of future data will assist in determining if the indicated trends continue.

Phillips – Giltner vs. Big Springs West

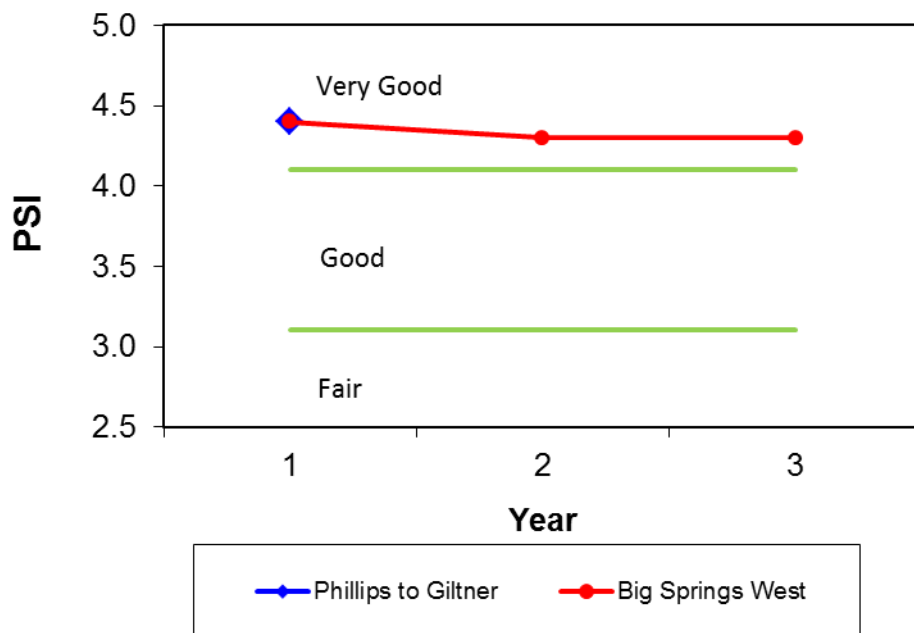
<i>Comparison 12</i>	Section	Age	HWY	CN	R.P.	Strategy	Cost Data
Experimental	Phillips-Giltner (new)	1	I-80	42415	318.58-324.55	SP5 with 5/8" leveling course plus a 1 3/8" layer	
Conventional	Big Springs West (new)	2	I-80	61285	102.09-106.31	SP5 with a standard 2" overlay	



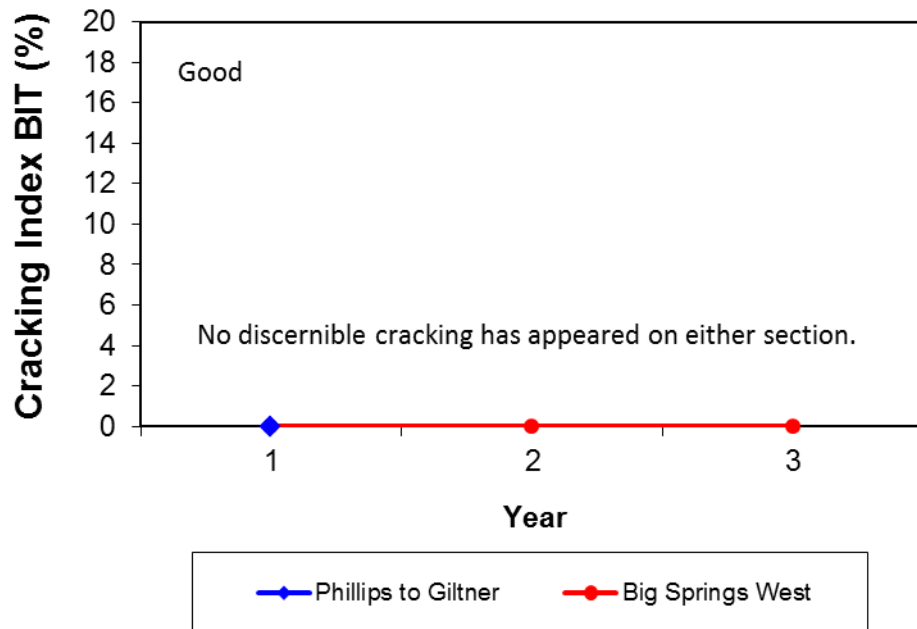
SP-5 with 5/8" Leveling Course Plus a 1-3/8" Layer vs. SP-5 with a Standard 2" Overlay



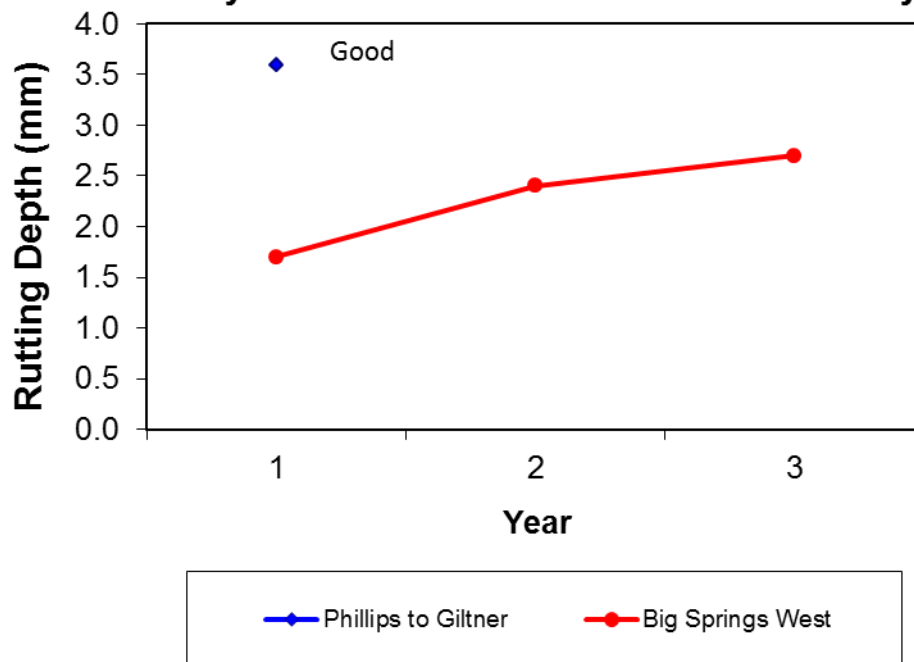
SP-5 with 5/8" Leveling Course Plus a 1-3/8" Layer vs. SP-5 with a Standard 2" Overlay



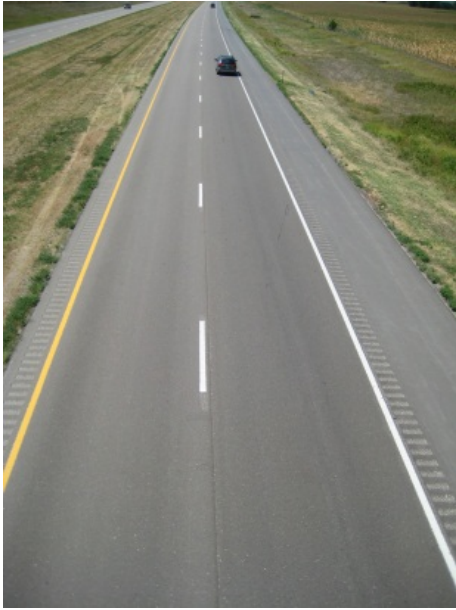
SP-5 with 5/8" Leveling Course Plus a 1-3/8" Layer vs. SP-5 with a Standard 2" Overlay



SP-5 with 5/8" Leveling Course Plus a 1-3/8" Layer vs. SP-5 with a Standard 2" Overlay



Phillips – Giltner (Experimental)



Big Springs West (Conventional)



Summary: The experimental section (Phillips to Giltner) has only one year of data available while the conventional section (Big Springs West) has three years of data. No cracking has been observed on either section. NSI and PSI appear almost identical for both sections in the first year. Phillips to Giltner exhibits slightly better IRI but worse rutting than Big Springs West in the first year. The sparseness of data makes indications of long-term trends very tentative. At present, neither section exhibits performance that is clearly superior to that of its counterpart. Collection of future data will assist in determining if the indicated trends continue

Summary of Pavement Performance

Experimental Section	Age	HWY	CN	R.P.	Strategy	Comparison Section	Age	HWY	CN	R.P.	Strategy
Gibbon to Shelton	8/1	I-80	42117	283.70-290.97	1.5" Gap Graded Crumb Rubber over 2.5" SP-5 in driving lanes; passing lanes have 1.5" GGCRM	Minden to Gibbon	9	I-80	42156	279.48-283.70	4" of SP-5 in driving and passing lanes
US-20 to N-59	1	14	31582	170.97-179.14	2" overlay of GGCRMLV (low volume)	South Jct. of N15 - WCL Plymouth	8	4	11890	133.58-144.03	SP4 Special Mix, 3.5" thick
Berywn to Ansley	9	2	60894	287.35-294.36	White topping; 8" of doweled PCC over milled asphalt roadbed	Ansley to Mason City	11	2	60792	295.89-301.76	White topping; 9" of non-doweled PCC over milled asphalt roadbed
Alma to Republican City	5	136	70591	29.56-37.50	7" of SP-4 over 4" bituminous foundation course	Republican City to Naponee	5	136	70591A	37.50-41.59	4" of SP-4 over 10" FA slab bit (small section of 10" SP-4 on prepared subgrade)
Louisville East Plattsouth West	5	66 66	22204 22225	112.07-118.50 118.50-124.84	2" SP-4, 3 3/4" High RAP Base 2" SP-4, 3 3/4" High RAP Base	Malmö Spur West	5	79 & 92	12819	N-79: 22.48-23.50 N-92: 437.75-442.77	2.5" of SP-4 over 4" Hyd Lime Slurry Stab base
Rulo West	3	159	12995	3": 4.87-5.34, 6.34- 11.51, 12.43-13.34/ 1.5": 5.34-6.34, 11.51-12.43	3" SP-4 (Term Blend CR Binder) Mill 1.5"/Fill 1.5" SP-4 GTR Bind Mill 3"/Fill 3" SP-4 GTR Binder	Newcastle	4	12	31798	222.25-233.96	Mill 2-3"/Fill 3" SP-4 Special
Lyons North	3	77	31974	148.77-163.91	Microsurfacing (new spec.)	Lincoln East	4	34	19908C	332.64-341.48	Microsurfacing (old spec.)
US-81 to Leigh	3	91	31899	153.53-163.98 & 164.67-165.33	Mill 4"/Fill 4" High RAP Base. 2" Gap Graded Crumb Rubber Modified AC	Emerson to N. of Wakefield	3	9	31877	30.53-37.38	Mill 4"/Fill 4" HRB 2 1/2" SP4
Bennet North	3	43	13017	15.46-16.74	Mill 2"/Fill 2" SP-4 w/Dry Crumb Rubber Modified Binder	Lewiston E&W	4	4	12821	167.47-179.55	Mill 2"/Fill 2" SP-4 Special
Leigh to Dodge City Line	3	91	31985	165.33-182.85	Mill 2"/Fill 2" SP-4 w/Wet Crumb Rubber Modified Binder	Superior South	3	14	42544	0.00-1.90, 2.85-7.32	2" SP4, 3" SP4
Ogallala South	3	61	61436	78.68-81.71 81.71-82.71 82.71-85.11	1.5" Sp-4 on 1.5" HRB (no Fibermat) 1.5" SP-4 on Fibermat on 1.5" HRB 1.5" SP-4 on 1.5" HRB on Fibermat	N-92 to N-64	4	81	42440	95.26-104.80	2" SP-4 on non-woven fabric on 2" SP-4 over existing PCC
Phillips-Giltner	1	I-80	42415	318.58-324.55	SP5 with 5/8" leveling course plus a 1 3/8" layer	Big Springs West	3	I-80	61285	102.09-106.31	SP5 with a standard 2" overlay

Pavement Section Exhibiting Better Performance

Conclusions

The overall assessment of new strategies yielded mixed results, which indicates that the NDOR has a proactive and innovative pavement research program in progress. Of the twelve experimental strategies considered in this report, three appear to be performing better than their conventional counterparts while four conventional strategies appear to be performing worse than their experimental counterparts. Three experimental strategies appear to be performing almost identically to their conventional counterpart and two strategies are too new to be objectively evaluated.

Three experimental strategies that appear to be performing better than similar conventional pavement sections include doweled white-topping (Berwyn to Ansley), terminal-blended CRM binder (Rulo West) and dry crumb rubber modified binder (Bennett North). The Berwyn to Ansley doweled section exhibited higher NSI, lower IRI, higher PSI, lower faulting and lower slab distress than its non-doweled counterpart (Ansley to Mason City). Rulo West exhibited lower IRI, higher PSI and lower rutting than its conventional counterpart (Newcastle) while other parameters were similar. The Bennett North section has performed slightly better with regard to NSI and PSI and much better with regard to rutting than its conventional counterpart (Lewiston E & W) while other performance parameters are similar.

Four conventional strategies appear to be performing better than their experimental counterparts. Conventional SP-4 special (N-15 to WCL Plymouth) exhibited lower IRI and higher PSI with less cracking and less rutting than gap-graded crumb rubber (US-20 to N-59). This may, however, result from the difference in pavement thickness (3.5" of SP-4 on N-15 to WCL Plymouth versus 2" of GGCRM on US-20 to N-59) instead of representing an actual difference in quality of pavement. The older specifications for microsurfacing (Lincoln East) appear to be performing at least slightly better than the newer specifications (Lyons North), with Lincoln East exhibiting higher PSI but lower IRI and significantly lower rutting than Lyons North. Emerson to Wakefield (HRB conventional SP-4) has outperformed the experimental high RAP base GGCRM asphalt (US-81 to Leigh) with higher NSI but lower IRI and rutting. Conventional SP-4 (Superior South) appears to be performing better than CRM asphalt (Leigh to Dodge County Line) with higher NSI and PSI but lower IRI and rutting.

There appears to be no significant difference in performance resulting from placing 1.5" of gap-graded crumb rubber asphalt (Gibbon to Shelton) over SP-5 asphalt versus paving the entire depth with SP-5 (Minden to Gibbon). NSI was higher with decreased cracking on the Minden to Gibbon section while IRI was lower and rutting decreased on the Gibbon to Shelton section. A similar situation exists for Alma to Republican City (7" of SP-4 over bituminous foundation course) and Republican City to Naponee (4" of SP-4 over a bituminous foundation course). IRI

was higher and PSI lower on Alma to Republican City while Republican City to Naponee experienced worse rutting. High RAP base (Louisville East to Plattsmouth West) exhibited increased rutting, while conventional SP-4 (Malmo West Spur) has exhibited decreased NSI and PSI.

Two strategies that are too new to be objectively evaluated include fiber mat over cracked and sealed PCC (Ogallala South) and SP-5 with a leveling course (Phillips-Giltner). Data collection extends only through a few years, so indications of trends are tentative. Both experimental sections appear to be performing better with respect to IRI based upon the limited data collected. Conventional pavement (Big Springs) may be starting to exhibit increased rutting. Collection of future data will assist in determining if the indicated trends continue.