58th Annual IAC

University of Idaho

ASPHALT INSTITUTE

IDAHO TRANSPORTATION DEPARTMENT

Maximizing Pavement Life – Part 1

Considerations for Pavement Design

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Moscow, Idaho

A.K.A.- How To

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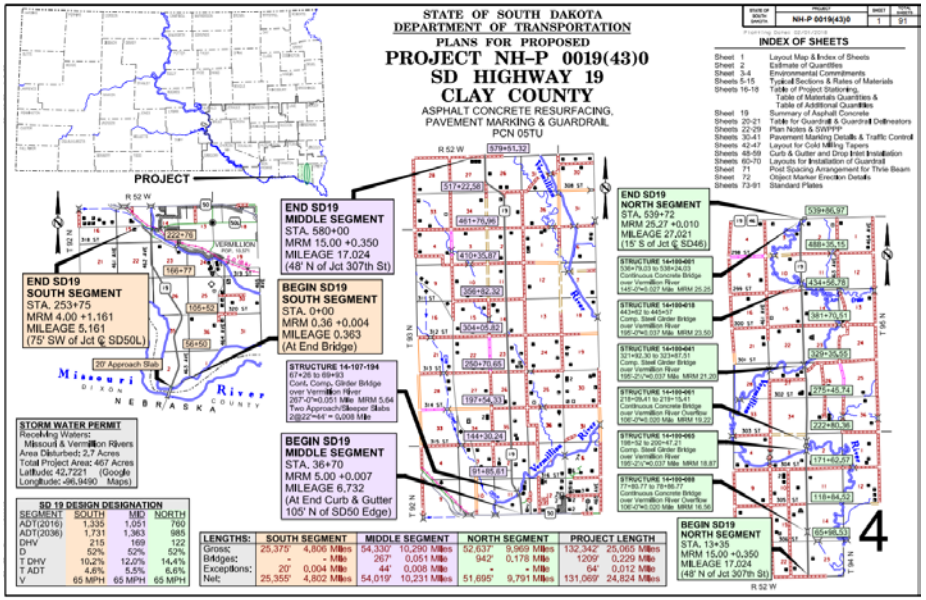
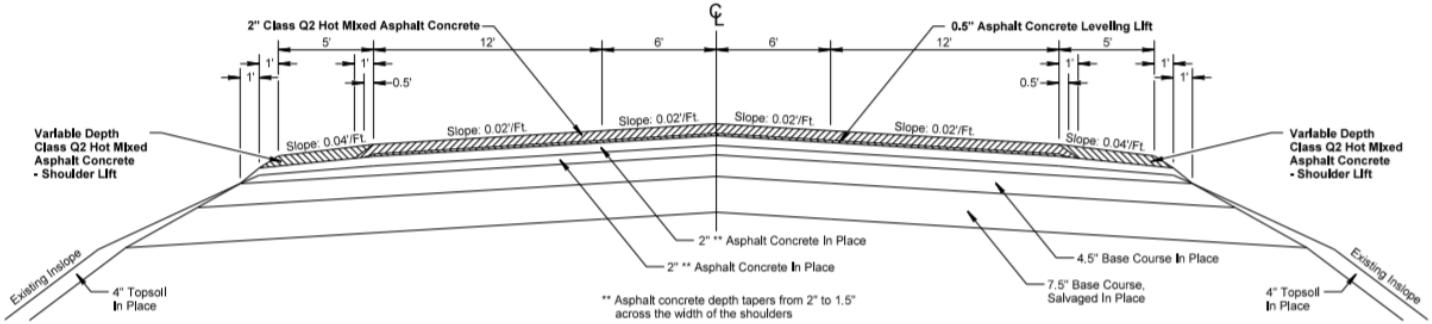
Design, Construct and Maintain HMA Pavements to Maximize Pavement Life

Pavement Design

1. Binder Type
2. Pavement Thickness
3. Lift Thickness & Mix Type



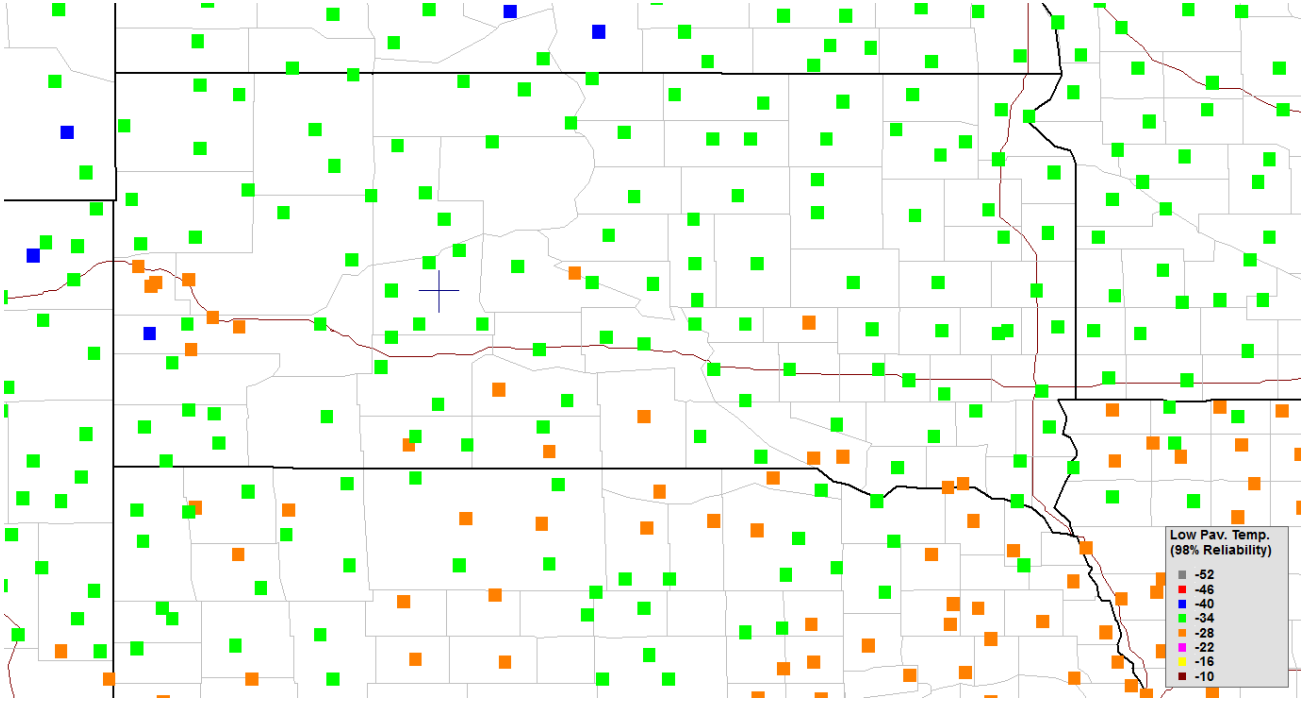


Binder Type

Design - Section 1

Prevent Thermal Cracking

- Use PG -34 Binders on New Construction
- 25 year old SHRP recommendation



LTPPBind v3.1
https://infopave.fhwa.dot.gov/Page/Index/LTPP_BIND

On overlays

Consider high performance binders on overlays

- Reduced rutting
- Reduced cracking
- Better crack seal performance
- Maintain existing crack resistance

PG 64-22 modified, no rutting

PG 67-22 unmodified, 15mm rut

Better Joint Performance

I-29 North of Beresford

- Orig. 1962 PCC
- 1999 - 3” HMA
- 2004 – 1.5” Class S
  - ✓PG 70-28
- 2004 – Saw/Seal
- 2009 – Sealed secondary cracks

But what does it cost?

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2016 SDDOT Ave. Unit Bid Prices

Description		Unit	Total Quantity	Average Bid Price
PG 58-28	Asphalt Binder	Ton	15,547.30	$433.74
PG 58-34	Asphalt Binder	Ton	125,661.00	$485.86
PG 64-22	Asphalt Binder	Ton	519.60	$470.63
PG 64-28	Asphalt Binder	Ton	182,175.80	$457.38
PG 64-34	Asphalt Binder	Ton	61,502.20	$499.15

Highest to Lowest Difference = $65.41/ binder ton
@ 6% Binder = $3.92 / ton of mix

Simple county overlay

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10 mile overlay, No milling

Item	Quantity	Units	Unit Price	Amount	% of Project Cost
PG64-28	1,575.50	Ton	$ 462.07	$ 727,991.29	48.5%
Class E Mix	25,627.20	Ton	$ 22.82	$ 584,812.70	39.0%
% Binder	6.1%	Tot. Mix Cost =		$ 1,312,803.99	87.5%
		Tot Project Cost =		$ 1,500,814.57	100.0%

Assuming a $65.41 binder cost increase,

		Expected Service Life (Years)	Needed increase in Life (Years)
Binder cost increase	14.2%	15	1.0
Project cost increase	6.9%	20	1.4
		25	1.7

Complicated Interstate overlay

20 + mile overlay, underdrains etc.

Item	Quantity	Units	Unit Price	Amount	% of Project Cost
PG64-28	1,823.80	Ton	$ 400.00	$ 729,520.00	3%
PG64-34	11,152.60	Ton	$ 430.00	$ 4,795,618.00	21%
			Tot Project Cost =	$ 22,565,024.00	

Assuming a $65.41 binder cost increase,

		Expected Service Life (Years)	Needed increase in Life (Years)
Binder cost increase	15.4%	15	0.6
Project cost increase	3.8%	20	0.8
		25	0.9

Smaller Urban / Grading

1 mile 3-Lane, grading, C&G, sidewalks, lighting and new asphalt surface

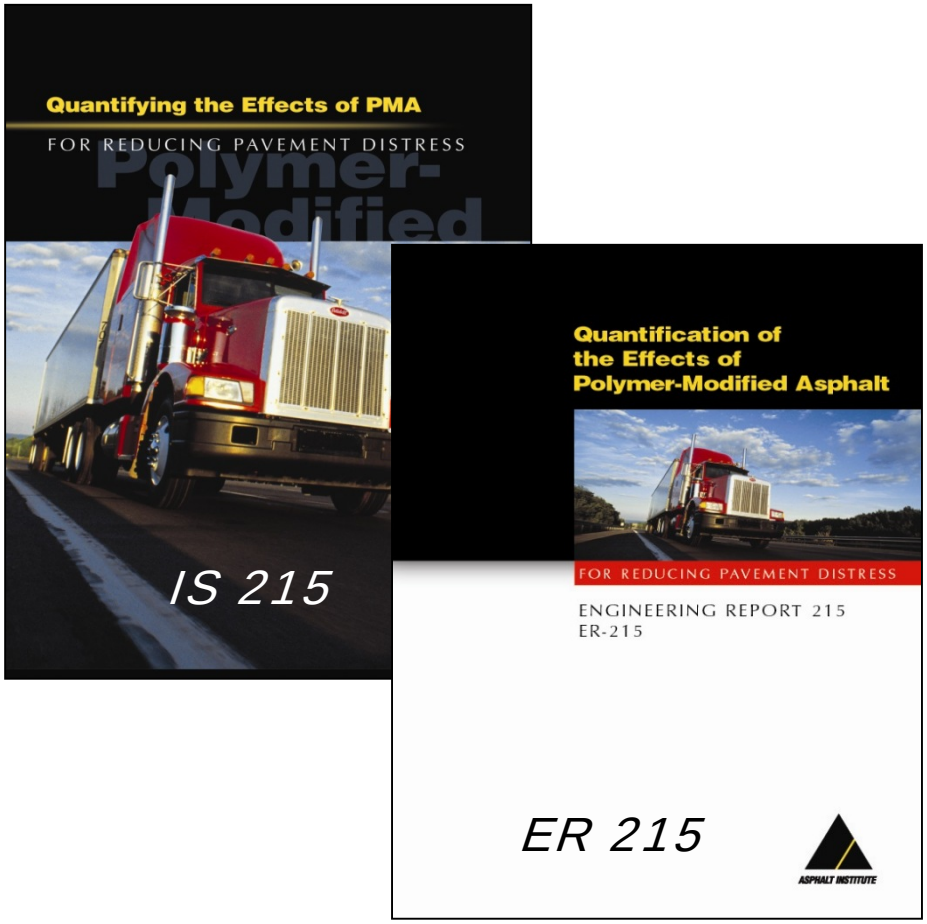
Item	Quantity	Units	Unit Price		Amount	% of Project Cost
PG58-28	447.70	Ton	$ 730.00	$	326,821.00	9.3%
Class HR	9,518.50	Ton	$ 33.00	$	314,110.50	8.9%
% Binder	4.7%	Tot. Mix Cost =		$	640,931.50	18.2%
		Tot Project Cost =		$	3,521,707.00	

Assuming a $65.41 binder mix cost increase,

		Expected Service Life (Years)	Needed increase in Life (Years)
Binder cost increase	9.0%	15	0.12
Project cost increase	0.8%	20	0.17
		25	0.21

LTPP Studies

Quantifying the Effects of PMA for Reducing Pavement Distress



This study (published in Feb 2005) used national field data to determine enhanced service life of pavements containing polymer modified binders versus conventional binders. The data is from a variety of climates and traffic volumes within North America.

Summary of Expected Increase in Service Life, Years, Based on M-E Damage Based Analysis

Assumptions: Unmodified sections designed for 20 yr. life. Also, PMA in top 4 inches.

Site Factor	Condition Description		Added Life
Foundation	Non-expansive, coarse soils		5-10
	Expansive and plastic soils (PI>35)		2-5
	Frost Susceptible in cold climate		2-5
Water Table & Drainage	Deep		5-10
	Shallow; adequate		5-8
	Shallow; inadequate		0-2
Existing Pavement Condition	HMA	Good	5-10
		Poor-extensive cracking	1-3
	PCC	Good	3-6
		Poor-faulting & cracking	0-2

Continued:
Summary of Expected Increase in Service Life, Yrs.

Assumptions: Unmodified sections designed for 20 yr. life. Also, PMA in top 4 inches.

Site Factor	Condition Description		Added Life
Climate; Temp. Fluctuations	Hot	Hot Extremes	5-10
	Mild		2-5
	Cold	Cold Extremes	3-6
Traffic, Truck Volumes	Low	Intersections	5-10
		Thoroughfares	3-6
		Heavy Loads	5-10
	Moderate		5-10
	High		5-10

Recycled Binders

NCHRP Project D9-12

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NCHRP REPORT 452 - Results

- Blending occurs at higher RAP contents. At low RAP contents, effects are not significant.
- Results from all phases support concept of a tiered system.
  - Mix ETG recommendations were largely confirmed.

NCHRP 9-12 Recommendations

RAP mixtures should be able to perform at least as well as virgin mixes.

ACTION	RAP
No Change in Binder Grade	15% or less
One Grade Lower	16 - 25%
Use Blending Charts	>25%

Adopted in AASHTO M323

Superpave Volumetric Mix Design

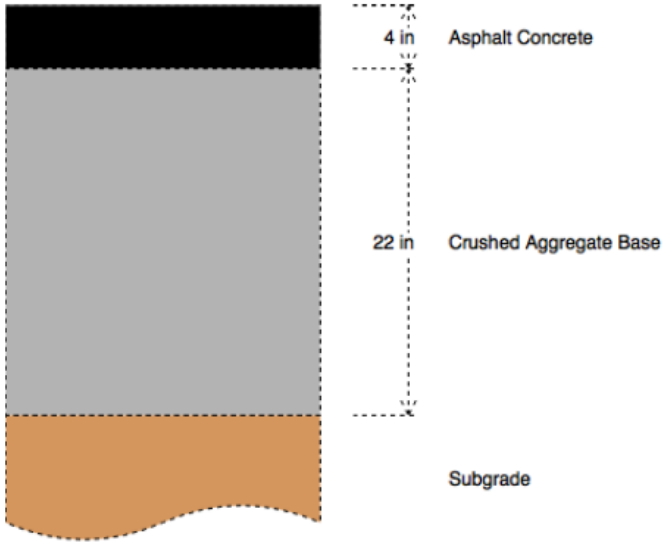
Moderation is the key

Project #1:
High RAP (RAS) + WMA Accelerated Pavement Test

The Experiment

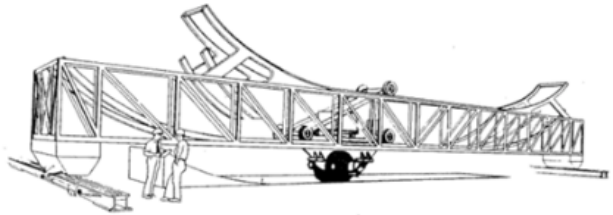
Structure

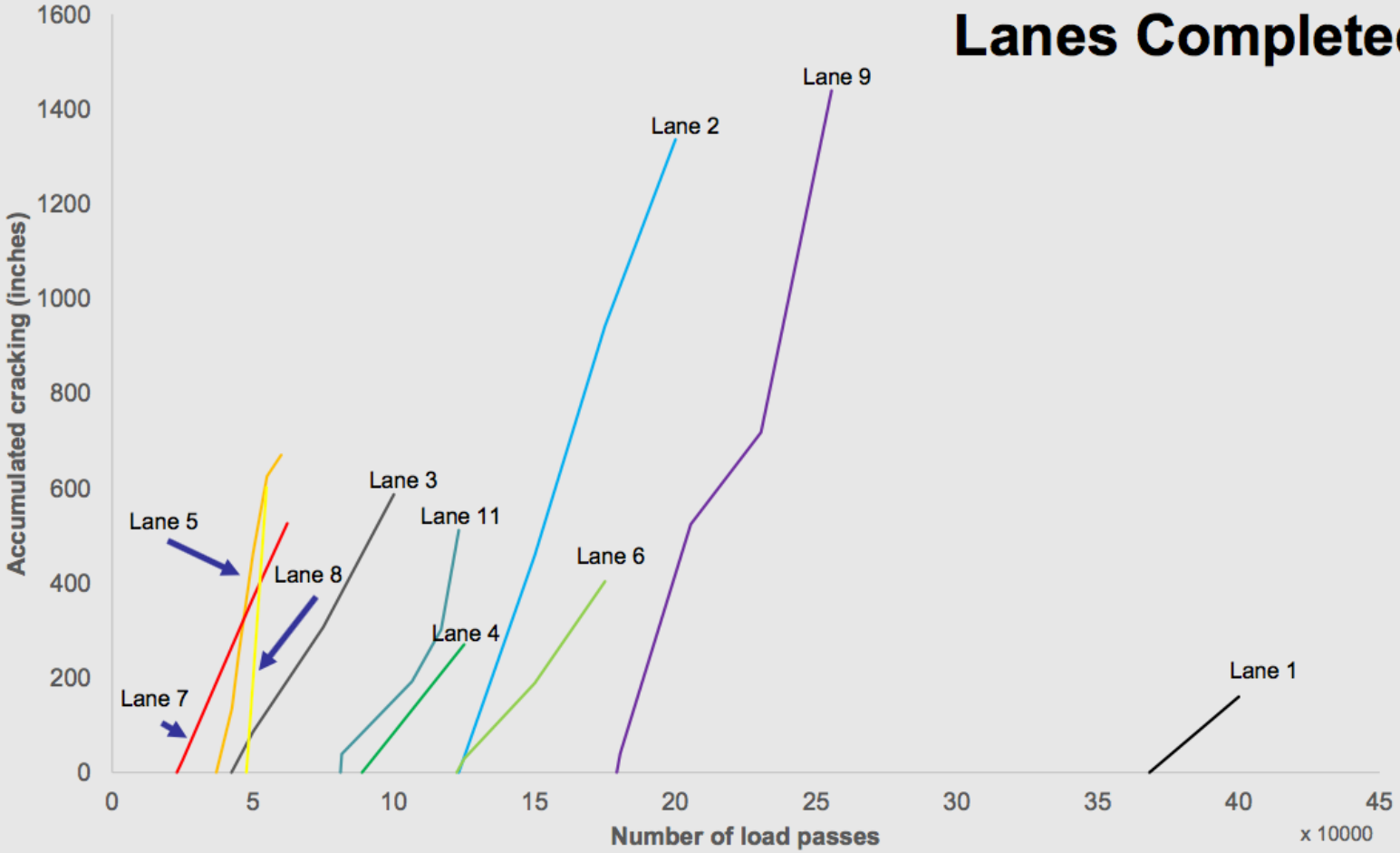
- 10 Lanes (10 Mixes)
- Build in 2013



Materials

- 2 Binder Grades
- RAP/RAS
- 2 WMA Technologies
- 3 ABR contents




Lanes Completed
Accumulated cracking (inches)
1600
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
35
40
45
Number of load passes
x 10000
Lane 9
Lane 2
Lane 3
Lane 11
Lane 5
Lane 8
Lane 6
Lane 4
Lane 7
Lane 1
Lane 1-0% ABR Control PG64-22
Lane 2-40% ABR RAP PG58-28 WMA Foamed
Lane 3-20% ABR RAS PG64-22
Lane 4-20% ABR RAP PG64-22 WMA Evotherm
Lane 5-40% ABR RAP PG64-22
Lane 6-20% ABR RAP PG64-22
Lane 7-20% ABR RAS PG58-22
Lane 8-40% ABR RAP PG58-22 WMA Evotherm
Lane 9-20% ABR RAP PG64-22 WMA Foamed
Lane 11-40% ABR RAP PG58-28

Acknowledgement

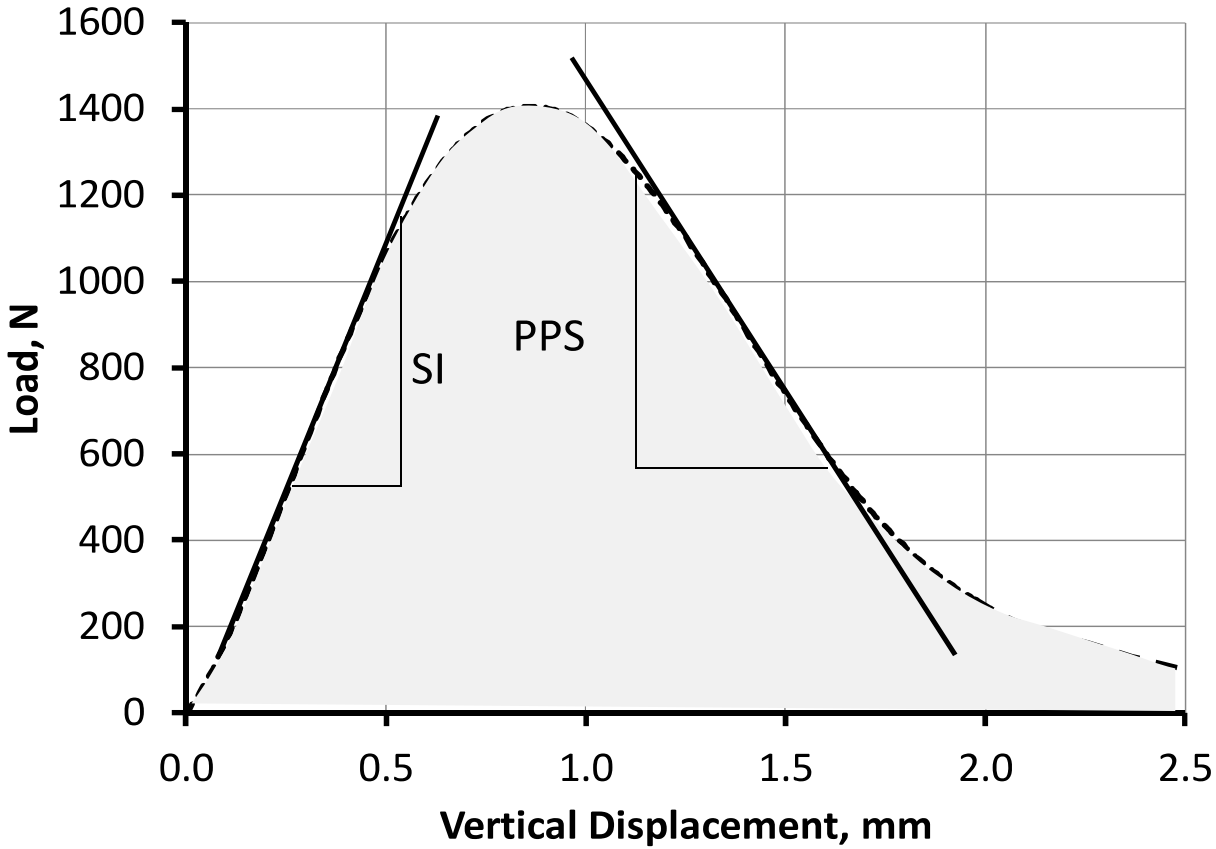
WHRP
Wisconsin Highway Research Program

- Project 0092-14-06 Critical Factors Affecting Asphalt Durability
  - Evaluate changes to the composition of asphalt mixtures that WisDOT should consider to improve durability
    - Resistance to load associated cracking
    - Resistance to aging

http://wisconsindot.gov/documents2/research/14-06-revised-final-report.pdf

Illinois SCB (Flexibility Index)

SI = Stiffness Index
Slope @ 50% of Peak Load
AI=Aging Index
$=SI_{LTOA}/SI_{STOA}$



FI = Energy/Post Peak Slope
Resistance to cracking increases with increasing FI

Effect of Recycled Binder

No Grade Change

VBE	Low Grade	RBR	FI	% of Control Life
10.5	-28	0.00	6.5	100
10.5	-28	0.05	6.0	92
10.5	-28	0.10	5.5	84
10.5	-28	0.15	5.0	77
10.5	-28	0.20	4.5	69
10.5	-28	0.25	4.0	61
10.5	-28	0.30	3.5	53

AASHTO M 323 Change

VBE	Low Grade	ABR	FI	% of Control Life
10.5	-28	0.00	6.5	100
10.5	-28	0.05	6.0	92
10.5	-28	0.10	5.5	84
10.5	-28	0.15	5.0	77
10.5	-34	0.20	6.9	105
10.5	-34	0.25	6.3	97
10.5	-34	0.30	5.8	89

Thickness Design

Design - Section 2

Pavement Design

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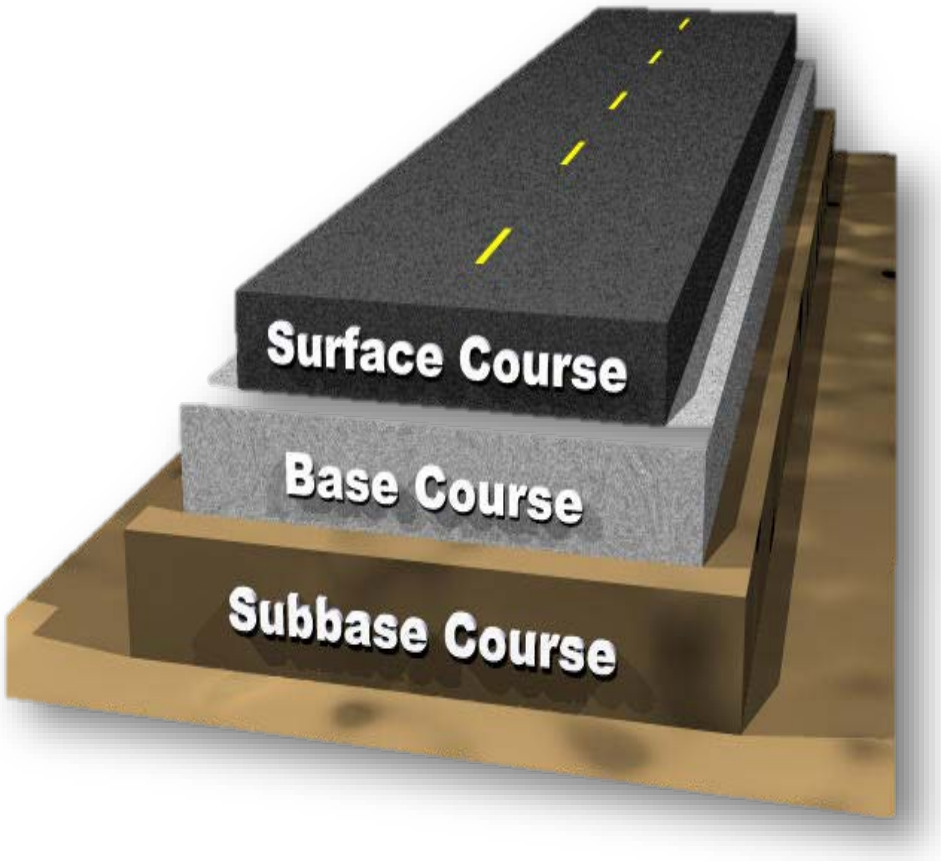
MEPDG *(AASHTO 2000)*



AASHTO has been developing MEPDG for high volume roads, but a gap has developed for local roads and lower volume roads.

What Is PaveXpress?

A free, online tool to help you create simplified pavement designs using key engineering inputs, based on the AASHTO 1993 and 1998 supplement pavement design process.

- Accessible via the web and mobile devices
- Free — no cost to use
- Based on AASHTO pavement design equations
- User-friendly
- Share, save, and print project designs
- Interactive help and resource links

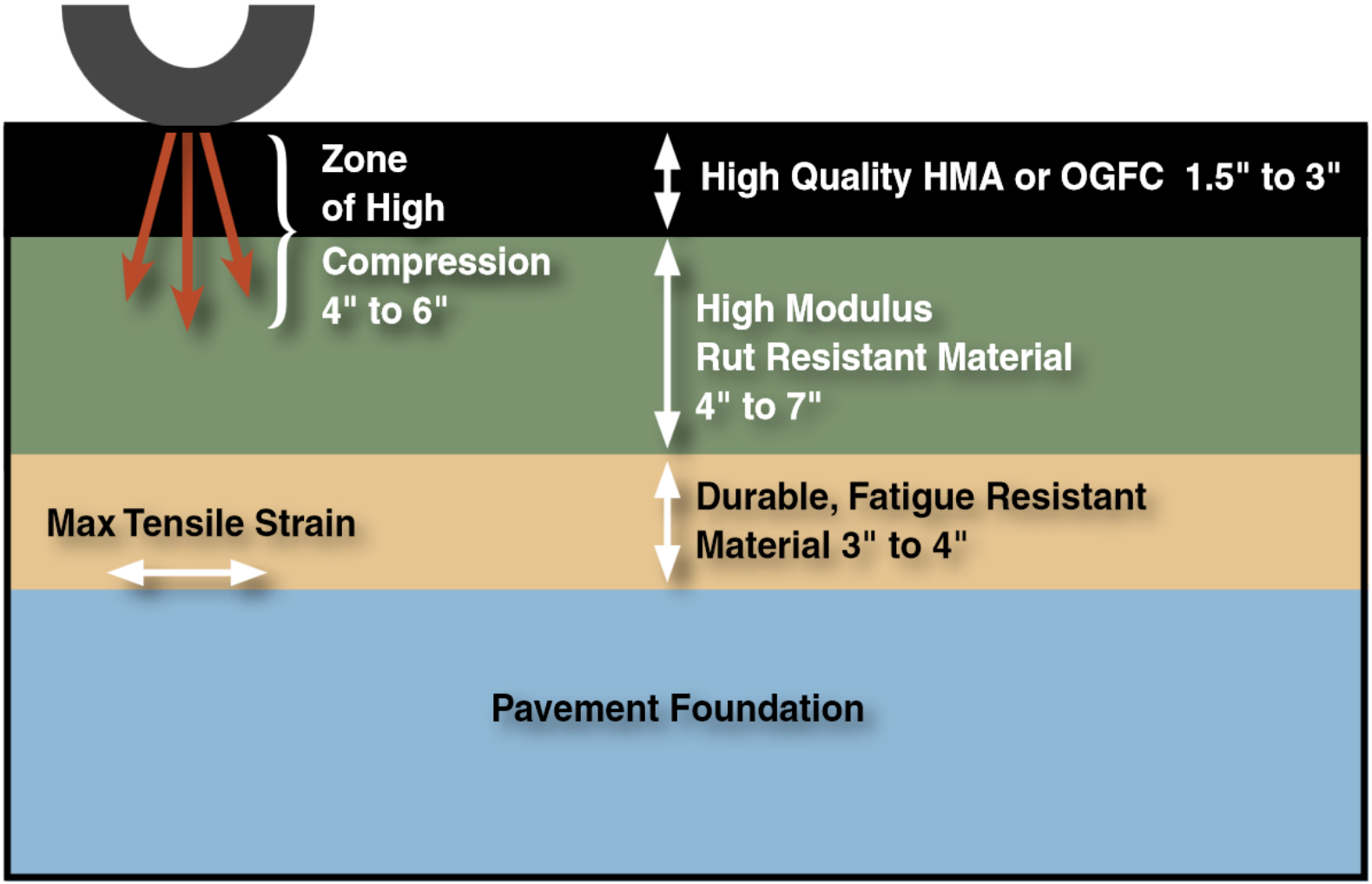
www.PaveXpressDesign.com

Perpetual Pavement Design Software

PerRoad is uses the mechanistic-empirical design philosophy. The program couples layered elastic analysis with a statistical analysis procedure (Monte Carlo simulation) to estimate stresses and strains within a pavement. In order to predict the strains which would prove detrimental for fatigue cracking or structural rutting.

www.asphaltroads.org/perpetual-pavement

What does a P. P. look like?



Ya But, Ya But Does Asphalt Really Last ?

I-90 W of Wall ≈ 860 TADT

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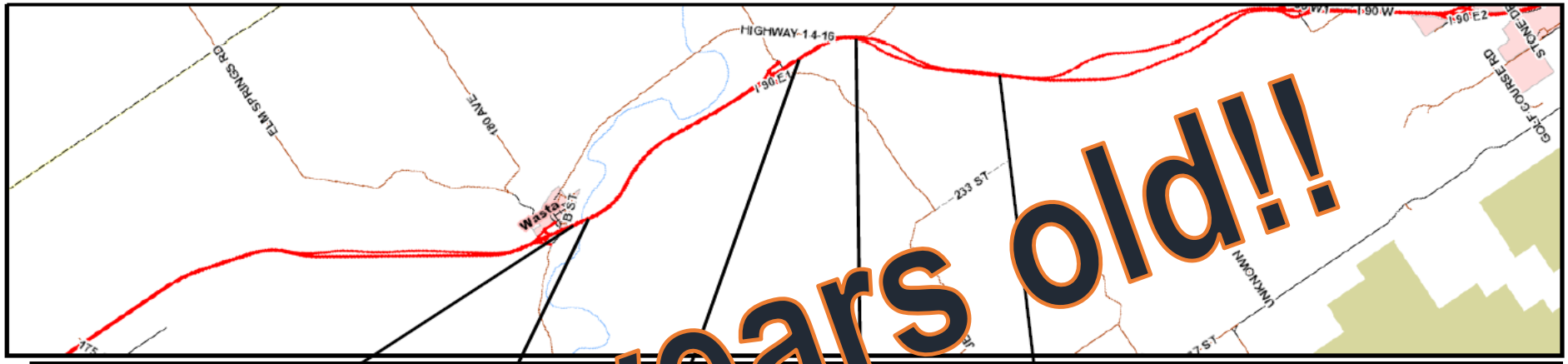
HIGHWAY 090 E
Beginning MRM = 98.14
Ending MRM = 102.00

RURAL

HIGHWAY 090 E
Beginning MRM = 98.14
Ending MRM = 102.00



65+ years old!!

STRUCTURAL DESCRIPTION				
Surf[illegible]ype	[illegible]	THK	FD	FD
Shouldr Type[illegible]im/[illegible]econdry		AC/N/D	AC/N/D	AC/N/D
Su[illegible]	32 (032)	24 (024)	24 (024)	24 (024)
Lf Shldr Widt[illegible]Second	[illegible]00) / (0)	4 (04) / (0)	4 (04) / (0)	4 (04) / (0)
Rt Shldr Width[illegible]im[illegible]	0 (00) / (0)	10 (10) / (0)	10 (10) / (0)	10 (10) / (0)
Widths-RDWY/RO[illegible]dom/Min	032/470/470	038/470/470	038/470/470	038/470/253
Roadbed Layer 1		2015/AS3/1.3	2015/AS3/1.3	2015/AS3/1.3
Roadbed Layer 2		2002/TC/0.0	2002/TC/0.0	2002/TC/0.0
Roadbed Layer 3		1999/AH3/1.5	1999/AH3/1.5	1999/AH3/1.5
Roadbed Layer 4		1999/AH3/1.5	1993/AG3/2.0	1999/AH3/1.5
Roadbed Layer 5		1977/AE4/3.5	1993/AG3/3.0	1977/AG4/2.0
Roadbed Layer 6		1964/AF3/1.5	1993/AG3/3.0	1969/AG3/2.0
Roadbed Layer 7		1964/BB3/4.0	1993/BS5/12.0	1969/AE3/6.0
Roadbed Layer 8		1964/BU5/4.0		1969/BU8/12.0
Roadbed Layer 9		1964/BU8/6.0		

I90 Cactus Flat W. ≈ 780 TADT

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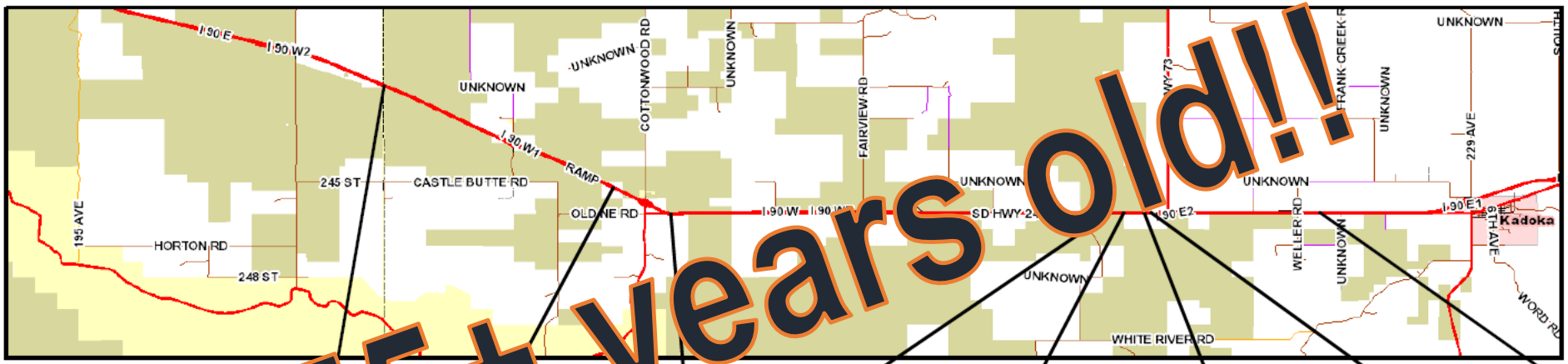
HIGHWAY 090 W
Beginning MRM = 124.23
Ending MRM = 142.00

RURAL

HIGHWAY 090 W
Beginning MRM = 124.23
Ending MRM = 142.00



55+ years old!!

STRUCTURAL DESCRIPTION	WBL	WBL	EBL	EBL
STRUCTURAL DESCRIPTION			CRCP	TKSJD
Surface Type	FD	FD	AC/N/D	AC/N/D
Shouldr Type - Prim/Secndry	AC/N/D	AC/N/D	24 (024)	26 (026)
Surf Width	24 (024)	24 (024)	4 (04)/ (0)	4 (04) / (0)
Lf Shldr Width-Prim/Secondry	10 (10) / (0)	10 (10) / (0)	10 (10)/ (0)	8 (08) / (0)
Rt Shldr Width-Prim/Secondry	4 (04) / (0)	4 (04) / (0)	038/200/200	038/250/200
Widths-RDWY/ROW-Predom/Min	038/220/220	038/220/220		
			1974/CC1/8.0	
Roadbed Layer 1	2012/TM/0.4	2012/TM/0.4	1974/BL3/4.0	2014/CD1/10.5
Roadbed Layer 2	2002/AS3/1.3	2002/AS3/1.3		2014/BS4/5.0
Roadbed Layer 3	2002/AH3/1.5	2002/AH3/1.5		
Roadbed Layer 4	1990/AR4/1.2	1974/AG3/3.0		
Roadbed Layer 5	1974/AG3/1.8	1974/AE3/9.0		
Roadbed Layer 6	1974/AE3/9.0	1974/BL3/12.0		
Roadbed Layer 7	1974/BL3/12.0			
Roadbed Layer 8				

115 D.R. West ≈ 190 TADT

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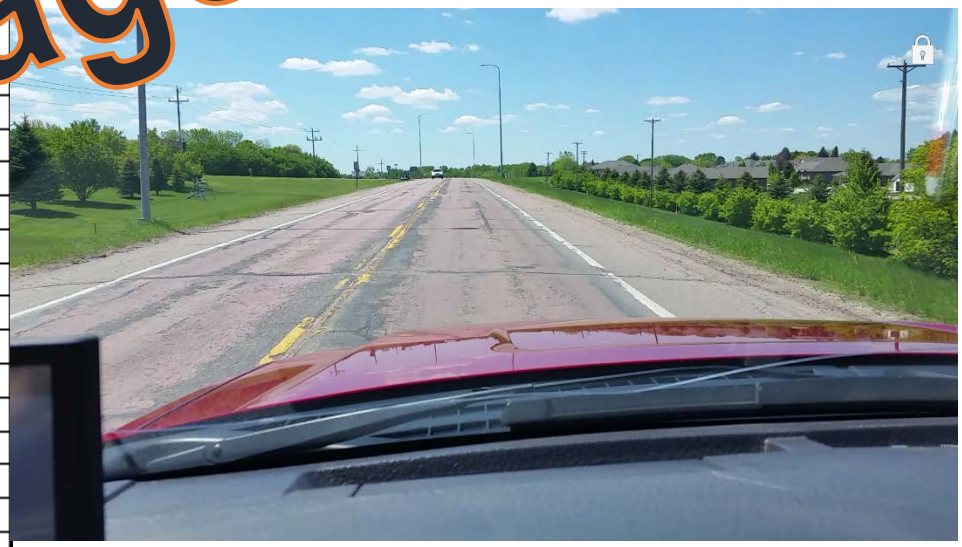
HIGHWAY 115
Beginning MRM = 104.13
Ending MRM = 107.51

RURAL

HIGHWAY 115
Beginning MRM = 104.13
Ending MRM = 107.51

Died, after 1 Overlay, at the age of 51!!!

STRUCTURAL DESCRIPTION	
Surface Type	FD
Shouldr Type - Prim/Secondry	AC/N/D
Surface Width	24 (024)
Lf Shldr Width-Prim/Secondry	6 (06) / (0)
Rt Shldr Width-Prim/Secondry	6 (06) / (0)
Widths-RDWY/ROW-Prim/Min	036/200/200
Roadbed Layer 1	2008/TS3/0.4
Roadbed Layer 2	1999/TC/0.0
Roadbed Layer 3	1990/TS3/0.5
Roadbed Layer 4	1986/AG3/2.0
Roadbed Layer 5	1975/TS3/0.5
Roadbed Layer 6	1967/AG3/3.0
Roadbed Layer 7	1967/AE3/5.0
Roadbed Layer 8	1967/BU8/12.0



How it looks today