

Evaluating the Effectiveness of Full Depth Pavement Reclamation



Delaware County, Ohio

Chris Bauserman, PE, PS

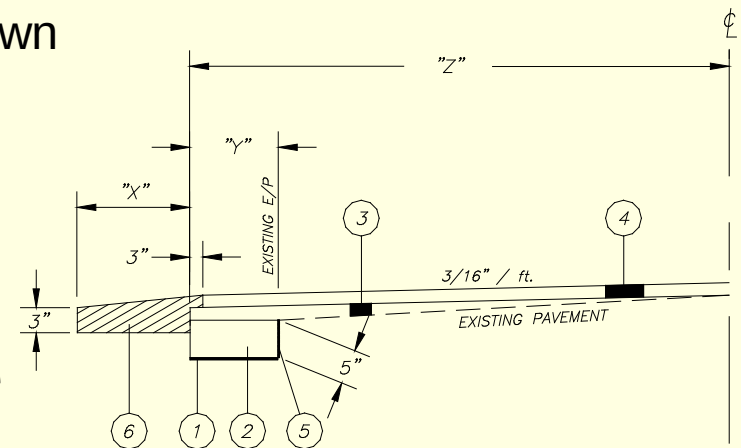
December 8, 2014

Background

- Population has increased from 55,000 in 1989 to approximately 200,000
- Explosive growth in residential, commuter, construction and commercial traffic
- County Highway system inadequate to meet demands of growth

1990's Road Conditions

- Narrow Roads – 18 feet or less with poor crown
- Predominantly Chip Seal surfaces
- Cross sections vary in thickness
 - Poor subgrade
 - Shallow aggregate base sections
- HMA projects were not performing well
 - Reflective cracking early in maintenance cycle
 - Loss of cross slope early in the maintenance cycle

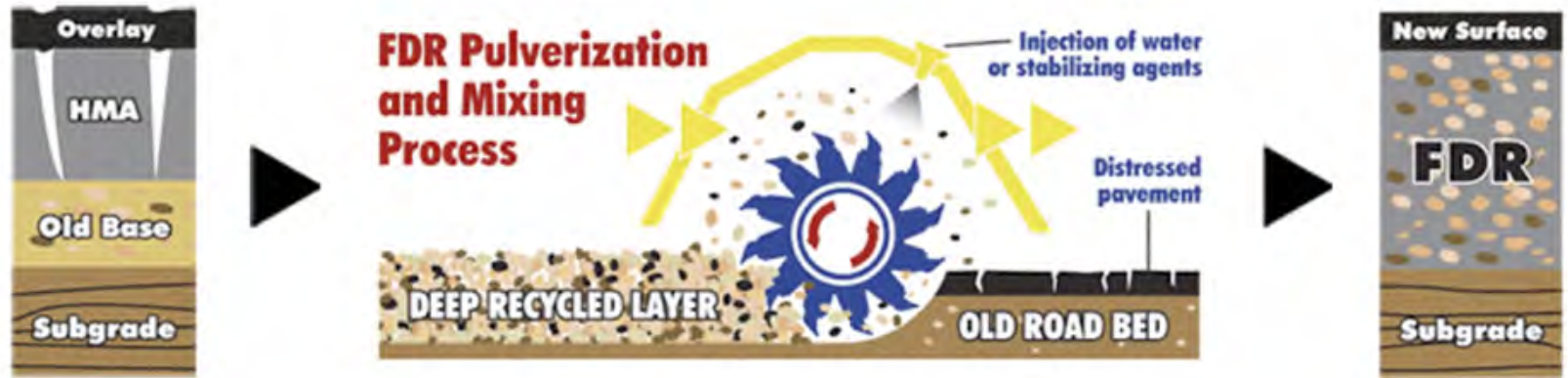


- ① 203 Linear Grading (per plan)
- ② 402 Asphalt Concrete (widening)
- ③ 403 Asphalt Concrete (1 3/4")
- ④ 404 Asphalt Concrete (1 1/4")
- ⑤ 407 Tack Coat (to be included in unit price for item 402.)
- ⑥ 617 Compacted Aggregate, type "A"

TYPICAL WIDENING & OVERLAY SECTION

Limiting Stations : 0+00 to 0+00

Full Depth Reclamation



- Pulverized flexible pavement section creating a uniform stabilized base
- Further Stabilization obtained through:
 - Addition of aggregate
 - Addition of stabilizers
 - Liquid Asphalt
 - Portland Cement

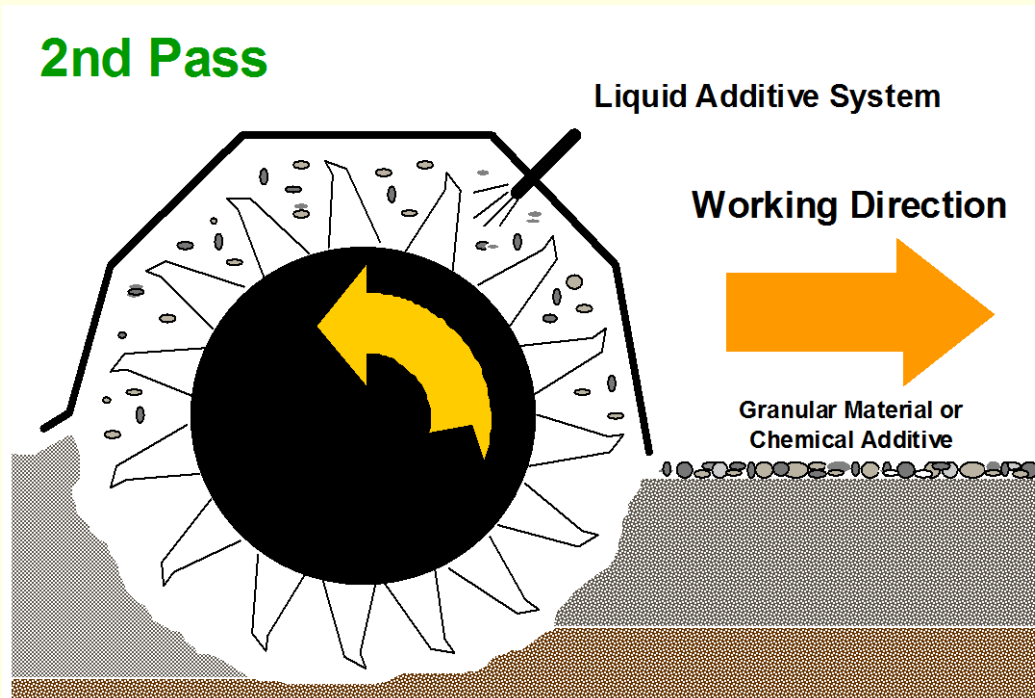
Full Depth Reclamation

■ Mechanical Stabilization – Aggregate



Full Depth Reclamation

- Chemical Stabilization
 - Liquid Asphalt

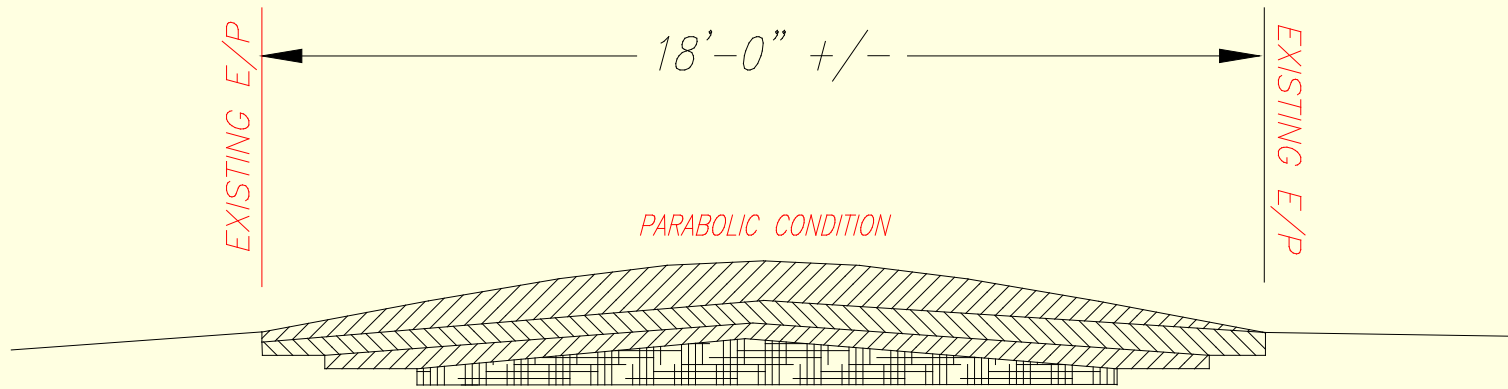


Full Depth Reclamation

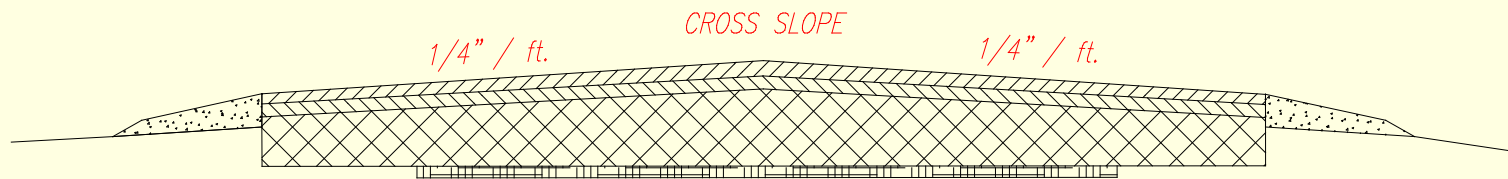
- Chemical Stabilization
 - Portland Cement



FDR - Slope Adjustments



EXISTING SECTION (BEFORE FDR)

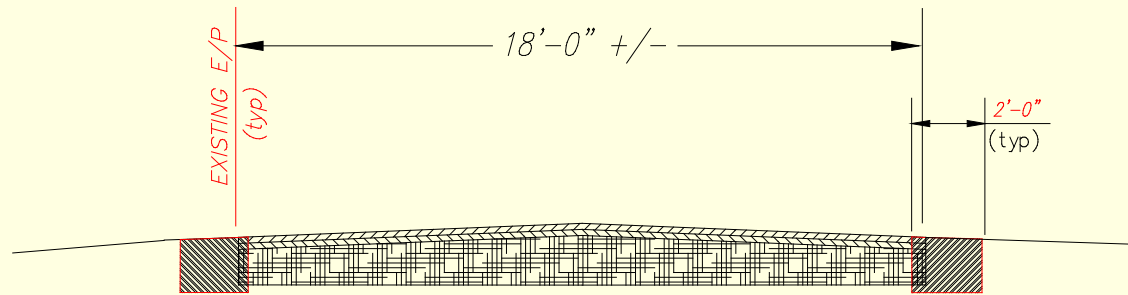


PROPOSED SECTION (AFTER FDR)

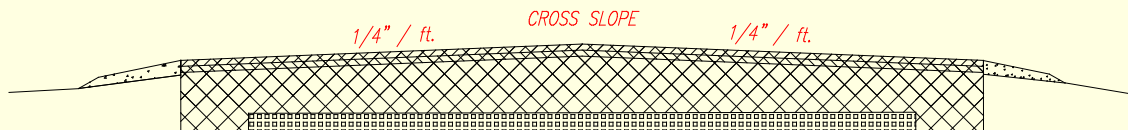
FDR - Slope Adjustments



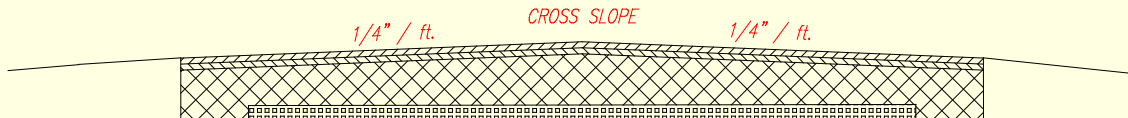
FDR – Pavement Widening



EXISTING SECTION (BEFORE FDR)



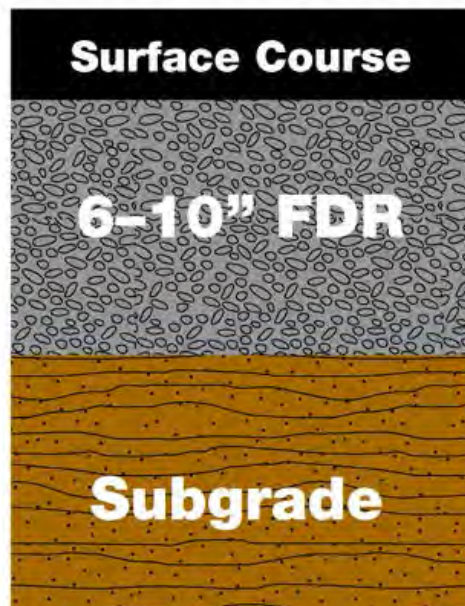
PROPOSED WIDENING SECTION (AFTER FDR WITH STONE)



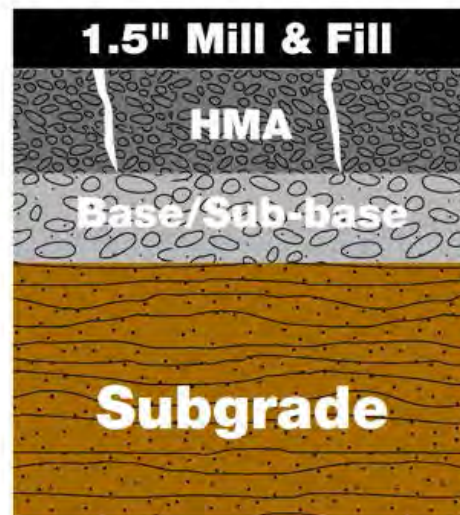
PROPOSED WIDENING SECTION (AFTER FDR W/O STONE)

FDR- Resists Reflective Cracking

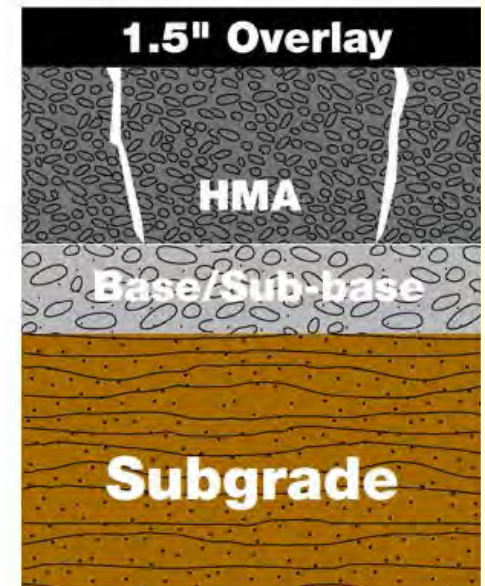
Full Depth Reclamation



Mill & Fill



Overlay



1997 FDR Test Section

- Norton Road
 - 4.7 mile section widening & overlay (3" depth)
 - 1.0 mile section FDR with 3 treatment variations
- Performed “Before and After” falling weight deflectometer tests at multiple locations on each section



Test Section

- **CONTROL SECTION (widening & 3" overlay)**
- **R-1 (aggregate)**
- **R-2 (aggregate & emulsion)**
- **R-3 (aggregate & portland cement)**

Test Section

- **CONTROL SECTION (widening & 3" overlay)**
 - Deflection reduced by **17.6%**
- **R-1 (aggregate)**
 - Deflection reduced by **41.7 %**
- **R-2 (aggregate & emulsion)**
 - Deflection reduced by **48.3%**
- **R-3 (aggregate & portland cement)**
 - Deflection reduced by **51.0%**

Full Depth Reclamation

DELAWARE COUNTY ENGINEERING DEPARTMENT RECLAMATION SUMMARY

12/7/2014

YEAR	ROAD DATA			
	#	NAME	MILEAGE	ADDITIVES
1997	202	Norton (test sections)	1.00	AGGREGATE/EMULSION/PORTLAND CEMENT
1998	25	Center Village	4.63	AGGREGATE & EMULSION
	65	County Home	2.41	AGGREGATE
	129	Concord	3.58	AGGREGATE
	131	Harriott	1.80	AGGREGATE
	163	Ostrander	4.35	AGGREGATE & EMULSION
	172	Warrensburg	3.30	AGGREGATE
	198	Radnor	6.37	AGGREGATE
1999	9	Liberty (Powell CL - Home)	2.96	COLD IN-PLACE RECYCLE
	17	Harlem	5.40	AGGREGATE
	18	Miller-Paul	5.97	AGGREGATE
	72	Cheshire	9.71	AGGREGATE & EMULSION
	246	Ashley	1.91	AGGREGATE
2000	10	Lackey Old State	2.65	AGGREGATE
	34	N. Galena	7.75	AGGREGATE
	34	S. Galena	2.04	AGGREGATE
	153	Ostrander South	1.31	AGGREGATE
	65	Kilbourne	6.16	AGGREGATE & EMULSION
	123	Hyatts	5.27	AGGREGATE & EMULSION
2001	7	Troy	7.19	AGGREGATE
2002	164	Fontanelle	1.70	AGGREGATE & EMULSION
	165	Burnt Pond	3.74	AGGREGATE & EMULSION
	170	Brindle	2.45	AGGREGATE
2003	14	East Powell	0.54	AGGREGATE & EMULSION
	39	Rome Corners	3.35	AGGREGATE & PORTLAND CEMENT
	109	Big Walnut	0.97	AGGREGATE & PORTLAND CEMENT
2005	224	Steamtown	5.93	CEMENT
2008	22	Trenton	2.45	AGGREGATE
2010	35	3B's & K	4.49	CEMENT
	96	Gregory	1.08	CEMENT
2014	136	Moore	1.21	CEMENT

97-14 TOTAL MILES
APPROXIMATE RECLAMATION \$

113.67
5.8 MILLION

Pavement Preservation

- Funding
- Commitment
 - Staff
 - Political
- Collect and maintain data on the condition of your system

Pavement Preservation

2014 Pavement Condition Record

HOME-2 (124)

HOME-2	124	LIMITS	HOME ROAD BRIC	to	US 23
BASE COMP	A/A	2004	CRACKING (50%)	10	*WHL BLOK *EDGE THRML LNGTDL
SURFACE	A	2013	SURFACE (30%)	9	*RAVEL BLEED PATCH DEBND CRACK
TREATMENT	n/a		*RUTTING (10%)	10	INTERSECTION LANE
LENGTH (LF / MI)	31,892	6,040	*DRAINAGE (10%)	10	POTHOLE HIBERM DFRMTION
WIDTH (ft.)	22.0		WEIGHTED AVG	9.7	97 PAVEMENT CONDITION RATING
STRAIGHT LINE (SF)	701,524		CRACKING (50%)	50	0.0
EXTRA LANE (LF)	16375		SURFACE (30%)	30	-3.0
EXTRA LANE (SF)	156,500		*RUTTING (10%)	10	0.0
TOTAL (SF)	898,124		*DRAINAGE (10%)	10	0.0
TOTAL (\$Y)	99,792		WEIGHTED DEDUCTS	-3	
INSPECTION DATE	24-Nov-14		BERM	3	2013
INSPECTED BY	MCM		ROAD MARKINGS	3	2013

PREVIOUS YEAR	CURRENT YEAR

ADDITIONAL PHOTOS		
SUMMARY OF IMPROVEMENTS		
1995	WIDEN, LEVEL/OVERLAY (1.5"/1.25")	\$276,700.00
1998-2001	FULL DEPTH REPAIR	\$62,900.00
2002	INTERSECTION IMPROVEMENT - MILL/FILL @ S	\$8,700.00
2002	INTERSECTION IMPROVEMENT - MILL/FILL @ S	\$6,200.00
2002	INTERSECTION IMPROVEMENT - MILL/FILL @ US	\$18,500.00
2004	FULL DEPTH REPAIR	\$31,400.00
2004	LEVEL/OVERLAY (1.5"/1.25")	\$242,300.00
2007	MILL, SAMI-F, SCRATCH/OVERLAY (1.25"/1.25")	\$236,200.00
	- SR257 TO SCIOTO RESERVE (EAST JOINT)	
2009	MICROSURFACE (SR257 TO SCIOTO RESERVE)	\$70,800.00
2011	FULL DEPTH REPAIR	\$11,600.00
2013	chip seal/level/overlay (1"/1.5") liberty rd to st	\$353,500.00
2014	CHIP LEVEL OVERLAY .75 & 1.25 FROM SAWMILL	\$300,000.00

HOME ROAD BRIC	to	US 23
CRACKING (50%)	10	*WHL BLOK *EDGE THRML LNGTDL
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Pavement Preservation

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Pavement Preservation Program

- How much surface treatment work?
 - Every year each system ages by 1 year
 - In order to maintain your system at the current level, preventative maintenance treatments and/or structural improvements are required that extend the remaining useful life by a number equal to your system mileage

Pavement Preservation Program

DELAWARE COUNTY ENGINEER'S OFFICE
ROAD IMPROVEMENT SUMMARY
1997 - 2014

YEAR	TOTAL MILES IMPROVED	TOTAL RECONSTRUCTION (HMA)	CONCRETE	FDR / HMA (LEVEL/OVERLAY)	FDR / HMA / CHIP SEAL	WIDENING / HMA	HMA (LEVEL/OVERLAY)	CHIP SEAL / HMA / MICRO	CHIP SEAL / HMA	HMA / MICRO	HMA / CHIP SEAL	HMA / CHIP SEAL / FOG	HMA (SURFACE ONLY)	COLD MIX / CHIP SEAL	CHIP SEAL / MICRO	MICRO ONLY	CHIP SEAL / FOG	CHIP SEAL (ONLY)	CRACK SEAL	TOTAL \$
EXPECTED	LIFE EXT	25	16	15	12	10	10	9	9	8	8	8	8	7	7	6	5	4	3	
1997	28.10	0.09		0.90			27.11													\$1,827,200
1998	49.52			24.70		8.72	16.10													\$4,196,802
1999	25.98			24.32			1.66													\$2,426,161
2000	47.60			25.62			0.13			7.98	13.87									\$3,548,900
2001	59.47			7.19			18.55				33.73									\$2,924,333
2002	27.97			7.89			19.32				0.76									\$1,992,005
2003	21.91			4.86			0.98			8.16	2.59		3.70			1.62				\$1,743,128
2004	47.96		0.19				13.14			4.35	7.31								22.97	\$2,010,124
2005	54.65			5.93						5.32	10.30		0.01	5.24				1.22	26.63	\$2,049,151
2006	64.93						1.88	9.03	1.26	1.43			1.48		6.08	30.89		7.35	5.53	\$2,224,692
2007	100.15						2.73		0.45	0.61			2.72		23.80	4.25		7.55	58.04	\$2,579,236
2008	77.17				2.45		10.10		3.89		1.50		1.77	1.26	2.67				53.53	\$2,980,922
2009	56.84			0.65				9.13		6.79			0.87				3.32		36.08	\$1,978,268
2010	49.76			1.08	4.49				0.09						18.98		10.12		15.00	\$2,605,394
2011	60.90								5.05						11.59		15.29	3.77	25.20	\$2,183,562
2012	37.84								12.04				0.61				17.56		7.63	\$2,580,013
2013	33.29								8.26			13.99					6.94		4.10	\$2,680,678
2014	35.61			1.21			1.31		5.55			3.76					9.81		13.97	\$2,296,541

879.65 0.09 0.19 104.35 6.94 8.72 113.01 18.16 36.59 34.64 70.06 17.75 11.16 6.50 63.12 36.76 63.04 19.89 268.68 \$44,827,109

TOTAL MILES IMPROVED 879.65
TOTAL FUNDS \$44,827,109.21
\$ / MILE \$51,000
\$ / YEAR \$2,490,400

FDR vs. Overlay Comparison

2014 Pavement Condition Record

CONCORD (129)

CONCORD	129	LIMITS	COOK (CON132)	US 42
BASE COMP	RMH	1998	CRACKING (50%)	8
SURFACE	N	2009	SURFACE (30%)	7
TREATMENT	#	2010	*KUTTING (10%)	10
LENGTH (LF / MI)	18,898	3,579	*DRAINAGE (10%)	9
WIDTH (FL)	18.0		WEIGHTED AVG	8.0
STRAIGHT LINE (SF)	340,164		CRACKING (50%)	50
EXTRA LANE (LF)			SURFACE (30%)	30
EXTRA LANE (SF)	0		*KUTTING (10%)	10
TOTAL (SF)	340,164		*DRAINAGE (10%)	10
TOTAL (SY)	37,796		WEIGHTED DEDUCTS	-20
INSPECTION DATE	10-Nov-14		BERM	2
INSPECTED BY	MCM		ROAD MARKINGS	4

PREVIOUS YEAR	CURRENT YEAR

ADDITIONAL PHOTOS

SUMMARY OF IMPROVEMENTS		
1998	RECLAMATION, LEVEL/OVERLAY (1.5"/1.25")	\$311,200.00
2002	CRACK SEAL	\$17,400.00
2006	INTERMEDIATE SEAL & MICROSURFACE	\$94,500.00
2009	FULL DEPTH REPAIR, AGGREGATE WEARING SURF - MOORE TO US42	\$63,300.00
2010	CRACK SEAL	\$10,100.00

TOTAL COST OF IMPROVEMENTS TO DATE \$496,500.00

Prepared by: The Delaware County Engineer's Office

2014 Pavement Condition Record

LIBERTY-3 (009)

LIBERTY-3	009	LIMITS	OLD LIBERTY (LI)	DEL. CTY. LIMIT
BASE COMP	A	2004	CRACKING (50%)	8
SURFACE	A	2012	SURFACE (30%)	9
TREATMENT	n/a		*KUTTING (10%)	10
LENGTH (LF / MI)	23,209	4,097	*DRAINAGE (10%)	10
WIDTH (FL)	23.0		WEIGHTED AVG	9.1
STRAIGHT LINE (SF)	531,807		CRACKING (50%)	50
EXTRA LANE (LF)	1965		SURFACE (30%)	30
EXTRA LANE (SF)	23,580		*KUTTING (10%)	10
TOTAL (SF)	587,397		*DRAINAGE (10%)	10
TOTAL (SY)	61,932		WEIGHTED DEDUCTS	-8
INSPECTION DATE	24-Nov-14		BERM	3
INSPECTED BY	MCM		ROAD MARKINGS	3

PREVIOUS YEAR	CURRENT YEAR

ADDITIONAL PHOTOS

SUMMARY OF IMPROVEMENTS		
1996	WIDENING, LEVEL/OVERLAY (1.25"/1.25")	\$306,700.00
2002	INTERSECTION IMPROVEMENT-MILL/FILL @ BU	\$14,800.00
2004	FULL DEPTH REPAIR	\$27,800.00
2004	LEVEL/OVERLAY (1.5"/1.25")	\$260,500.00
2012	CHIP SEAL/LEVEL/OVERLAY (.75"/1.5")	\$548,700.00

TOTAL COST OF IMPROVEMENTS TO DATE \$1,158,500.00

Prepared by: The Delaware County Engineer's Office

FDR vs. Overlay Comparison

- Analyzed amount of money spent on each FDR roadway and each structural overlay
 - Expressed in \$ per square yard per year
 - Excludes initial cost
 - Evaluates amount of subsequent expenditures by roadway segment

2014 Pavement Condition Record

9	RAVEL BLOW-EDGE THRESH. LIMIT
9	RAVEL BLEED PATCH DEBRD CRACK
10	INTERSECTION LANE
10	POTHOLE HIBERN DEFRACTION
R1	92 PAVEMENT CONDITION RATING
20	-5.0
30	-3.0
10	0.0
10	0.0
CTE	-8
9	2012
3	2012

ADDITIONAL PHOTOS		
SUMMARY OF IMPROVEMENTS		
1996	WIDENING, LEVEL/OVERLAY (1.25"/1.25")	\$306,700.00
2002	INTERSECTION IMPROVEMENT-MILL/FILL @ BU	\$14,800.00
2004	FULL DEPTH REPAIR	\$27,800.00
2004	LEVEL/OVERLAY (1.5"/1.25")	\$260,500.00
2012	CHIP SEAL/LEVEL/OVERLAY(.75"/1.5")	\$548,790.00
TOTAL COST OF IMPROVEMENTS TO DATE		\$1,158,590.00

FDR vs. Overlay Comparison

- Average for all applicable Delaware County roads:
 - Conventional Structural Overlay Segments
 - Average Expenditure **\$.80 / sy / year**
 - FDR w/ Structural Overlay Segments
 - Average Expenditure **\$.28 / sy / year**

FDR vs. Overlay Comparison

- **Initially**, FDR with overlay has cost **about twice as much** as the structural overlay
- **Long term**, FDR has **saved about two thirds** of subsequent surface treatment and repair costs
- This doesn't account for the additional benefits of crown correction and profile grade adjustments

Disadvantages of FDR

- ❑ Higher initial cost
- ❑ Traffic control is more difficult than conventional paving operation
- ❑ Initial Public reaction
- ❑ Length of disturbance is greater
- ❑ Destroys survey monuments in pavement

Advantages of FDR

- ❑ Lower long term cost
- ❑ Increased Pavement Strength
- ❑ Re-establishment and retention of cross-slope
- ❑ Reduction in reflective cracking
- ❑ Extended Maintenance Cycle
- ❑ Cost Effective - alternative to reconstruction
- ❑ Flexibility in stabilizers (stone, asphalt, cement)
- ❑ Public perception

Questions?

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