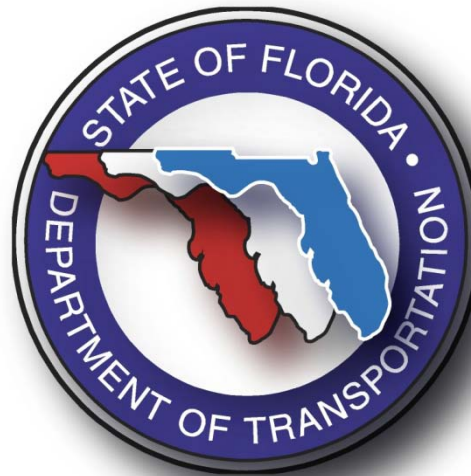
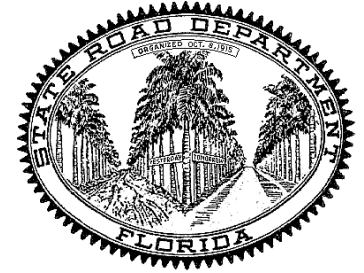


HMA Recycling in Florida

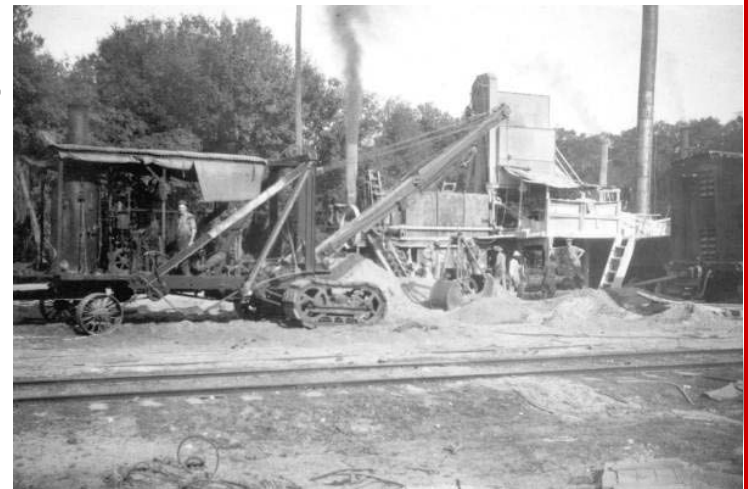


Jim Musselman
Florida Department of Transportation

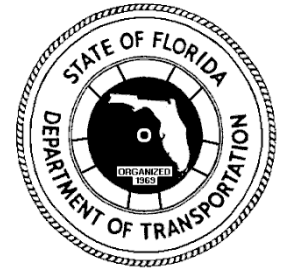
History of Recycling



- 1977: Palm Beach County
 - 28,000 tons HMA base w/25% RAP
 - RAP from another project
 - Batch plant (bypassed drier)
- 1978: Bay County
 - Milled 1”
 - Leveling course w/30% RAP
 - Factory modified batch plant

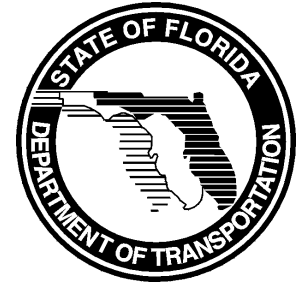


History



- 1979: Marion County
 - 65% RAP + 35% Local Sand
 - Asphalt Emulsion Rejuvenator
 - 35,000 tons
 - Drum Mix Plant





History

- 1980: Recycled HMA specifications developed as a standard practice
 - Contractor given ownership of RAP
 - Allowed up to 60% RAP in mix
 - FDOT monitored mix viscosity during production
 - All other construction specifications the same
 - FDOT supplied pavement composition report



Pavement Composition Report

FAP No. 1001-041-P
 SR - 25
 County - Hendry
 From Km.P. 6.336 to Km.P. 21.337
 From M.P. 3.937 to M.P. 13.258

NB & SB Traffic and Passing Lanes
 (4)

	RANGE	AVERAGE
Viscosity @ 60°C (pa·s)	445 - 11,861	3,620
Viscosity @ 140°F (Poises)	4,450 - 118,610	36,200
Penetration @ 25°C (0.1 mm)	14 - 45	27
Asphalt Content (%)	5.1 - 6.7	6.0
Gradation - Percent Passing		
25 mm (1")	100	100
19 mm (3/4")	99 - 100	100
12.5 mm (1/2")	98 - 100	99
9.5 mm (3/8")	85 - 94	90
4.75 mm (No. 4)	57 - 71	63
2.00 mm (No. 10)	44 - 57	49
425 µm (No. 40)	28 - 35	31
180 µm (No. 80)	13 - 22	16
75 µm (No. 200)	5.5 - 8.5	6.8
Total Pavement Thickness (mm)	85 - 291	140
Thickness Evaluated (mm)	Top 60	
Total Pavement Thickness (in.)	3.35 - 11.46	5.51
Thickness Evaluated (in.)	Top 2.25	

Viscosity

Asphalt Content

Gradation

Pavement Composition Report

State of Florida Department of Transportation

Pavement Composition Data Sheet

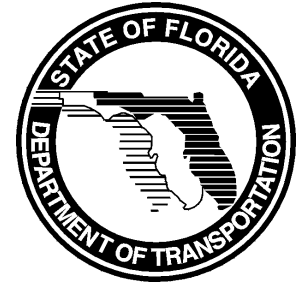
Date: May 9, 2005

Milling Depth : 2.50 in.

Page: 2 of 2

F. P. N. : 213003-2-52-01	S.R. No.: I-10	<u>Notes</u>
F. A. P. No. : 0105 121 i	From : Columbia C/L	
County : Baker	To : US 90	
No. of Lanes : 4	Beg M.P. : 0.000 End M.P. : 8.884	

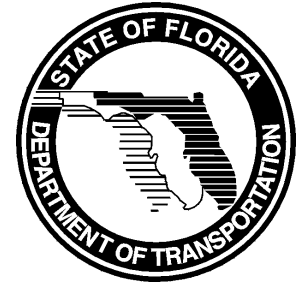
Core No.	M.P.	Lane	Pavement Layers (in.)							Core Length (in.)	Percent Passing Sieves									
			FC-2	S-I	S-II	ARMI	S-I	Bind			3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 20
1	0.100	R-1	0.50	1.40	1.80	0.50	2.10	1.00	---	7.30										
2	0.400	R-1	0.70	1.40	1.50	0.50	2.10	1.00	---	7.20										
3	0.700	R-1	0.50	1.30	1.20	0.50	3.50	---	---	7.00	100.00	94.93	88.48	57.16	42.76	36.79	31.71	20.95	9.11	4.6
4	1.100	R-1	0.50	1.30	1.60	0.50	3.30	0.50	---	7.70										
5	1.400	R-1	0.70	1.10	1.50	0.50	4.30	---	---	8.10										
6	1.700	R-1	0.60	1.20	1.50	0.50	3.60	0.80	---	8.20	100.00	95.00	87.69	57.34	42.49	36.78	31.95	20.55	8.29	4.6
7	2.100	R-1	0.50	1.50	1.30	0.50	3.80	0.70	---	8.30										
8	2.400	R-1	0.80	1.60	1.70	0.50	2.40	1.30	---	8.30										
9	2.700	R-1	0.50	1.20	1.20	0.50	2.50	1.50	---	7.40	100.00	93.24	84.84	55.49	41.60	35.83	30.86	19.30	7.86	4.5
10	3.100	R-1	0.40	1.50	1.30	0.50	3.80	0.50	---	8.00										



History

- Mid 1980's: FDOT experienced rutting problems...
 - Low in-place air voids
 - high fines
 - Reduced maximum P_{-200} at design
 - Implemented better controls of P_{-200}
 - Began monitoring volumetrics
 - 1/4000 tons
- Resulted in a reduction of RAP usage





History

- Late 1990's: FDOT implemented Superpave.....
 - RAP usage declined further in order to meet design criteria (VMA, Dust/Effective)
- 2000's:
 - Implemented PWL Specifications
 - Increased use of polymer modified asphalts
 - Max 15% RAP



History



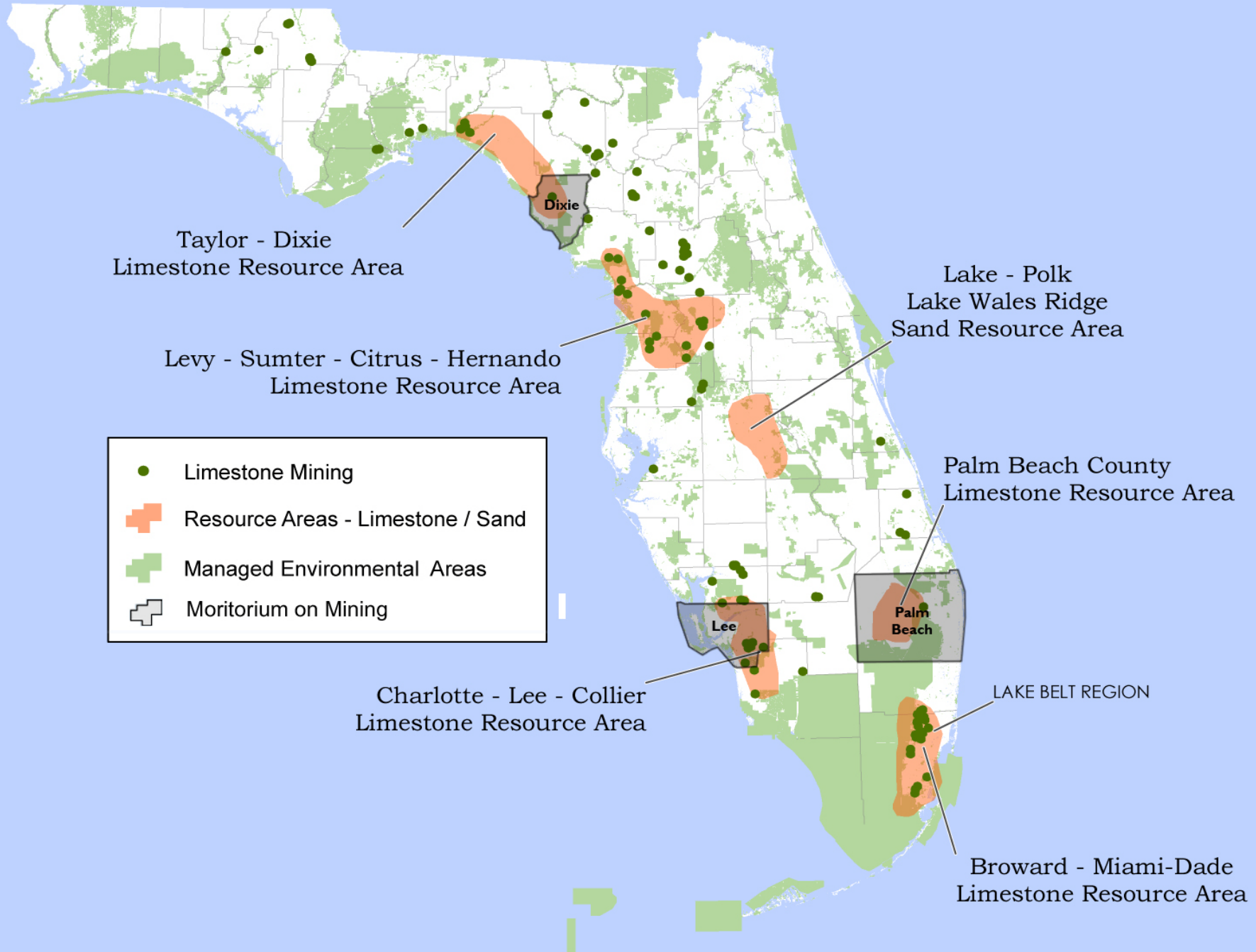
- Mid 2000's:
 - Significant growth in Florida
 - Increased work program
 - \$3 billion in construction
 - Increased materials costs
 - Binder \$350/ton
 - Aggregate \$22/ton
 - Materials shortages
 - Renewed interest in RAP usage



Construction Price Increases

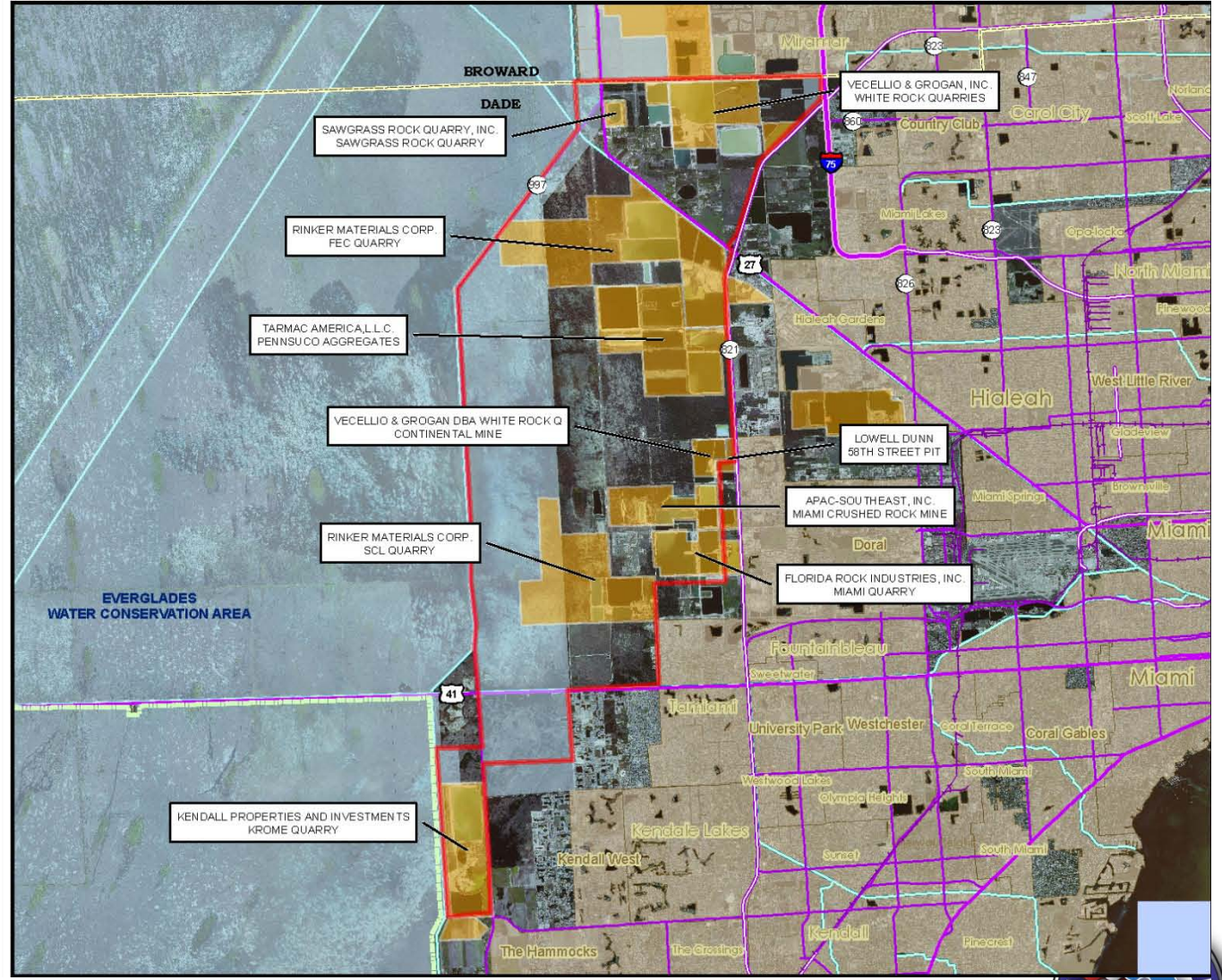
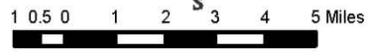
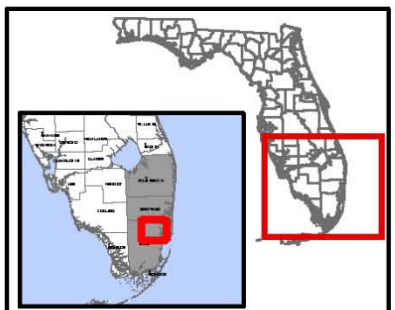
Pay Item Group	Unit	2003	2004	Change	2005	Change	2007 (Jan-June)	Change
Earthwork	CY	\$4.96	\$4.38	-11.7%	\$7.27	+66.0%	\$13.23	+82.0%
Asphalt	TN	\$53.10	\$58.71	+10.6%	\$68.83	+17.2%	\$103.01	+49.7%
Concrete (Structural)	CY	\$549.8 2	\$564.12	+2.6%	\$760.89	+34.9%	\$1113.79	+46.4%
Steel (Structural)	LB	\$1.06	\$1.48	+39.6%	\$1.57	+6.1%	\$2.25	+43.3%
Steel (Reinf.)	LB	\$0.52	\$0.75	+44.2%	\$0.91	+21.3%	\$0.99	+8.8%

LIMESTONE AND SAND RESOURCE AREAS



Lake Belt Region MINING ACTIVITY

- Dade County
- Everglades National Park
- Lake Belt Region
- Mine Boundary
- Managed Area
- Urban Area
- Interstate
- Florida Turnpike
- US Highway
- State Road
- Canal

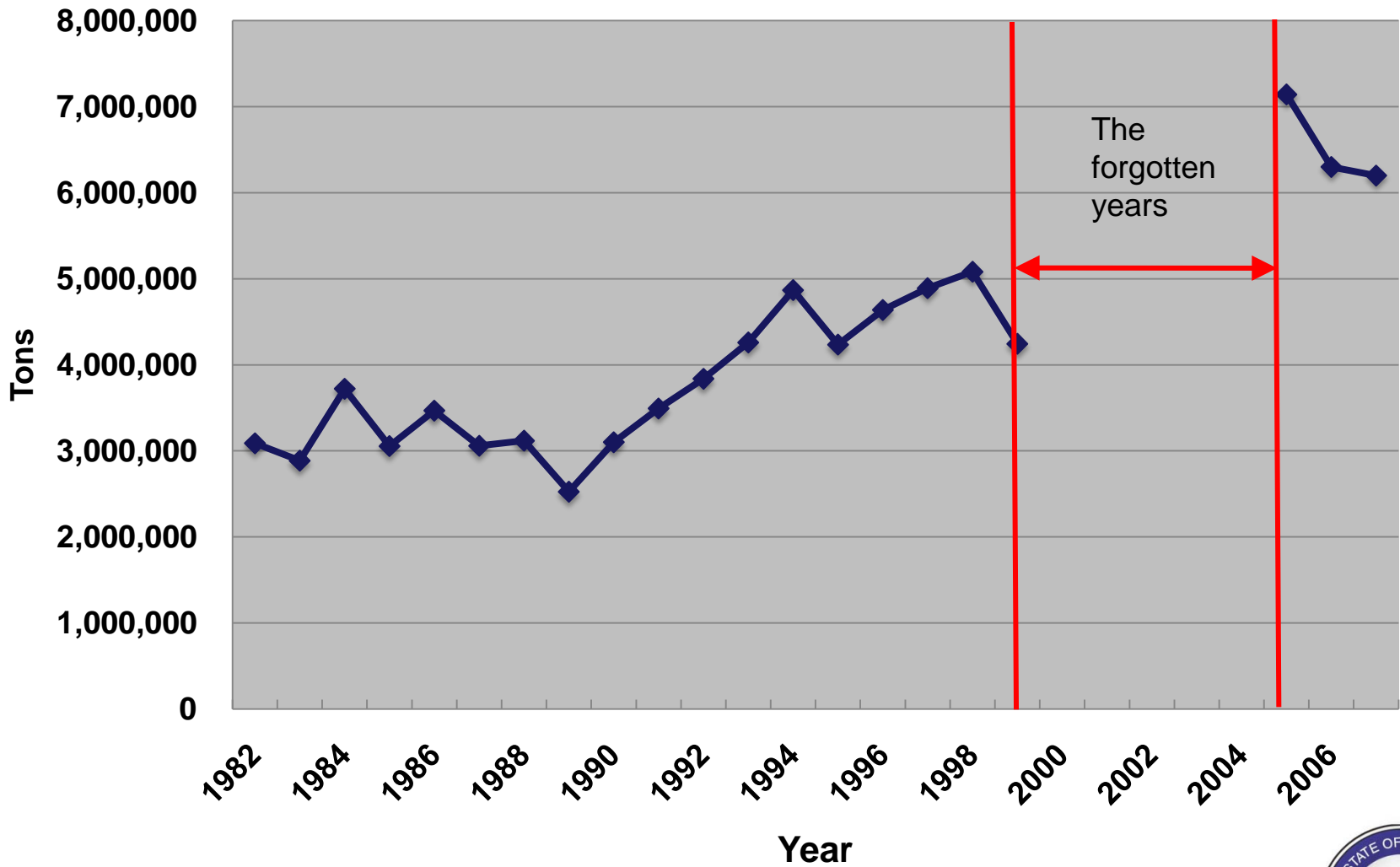




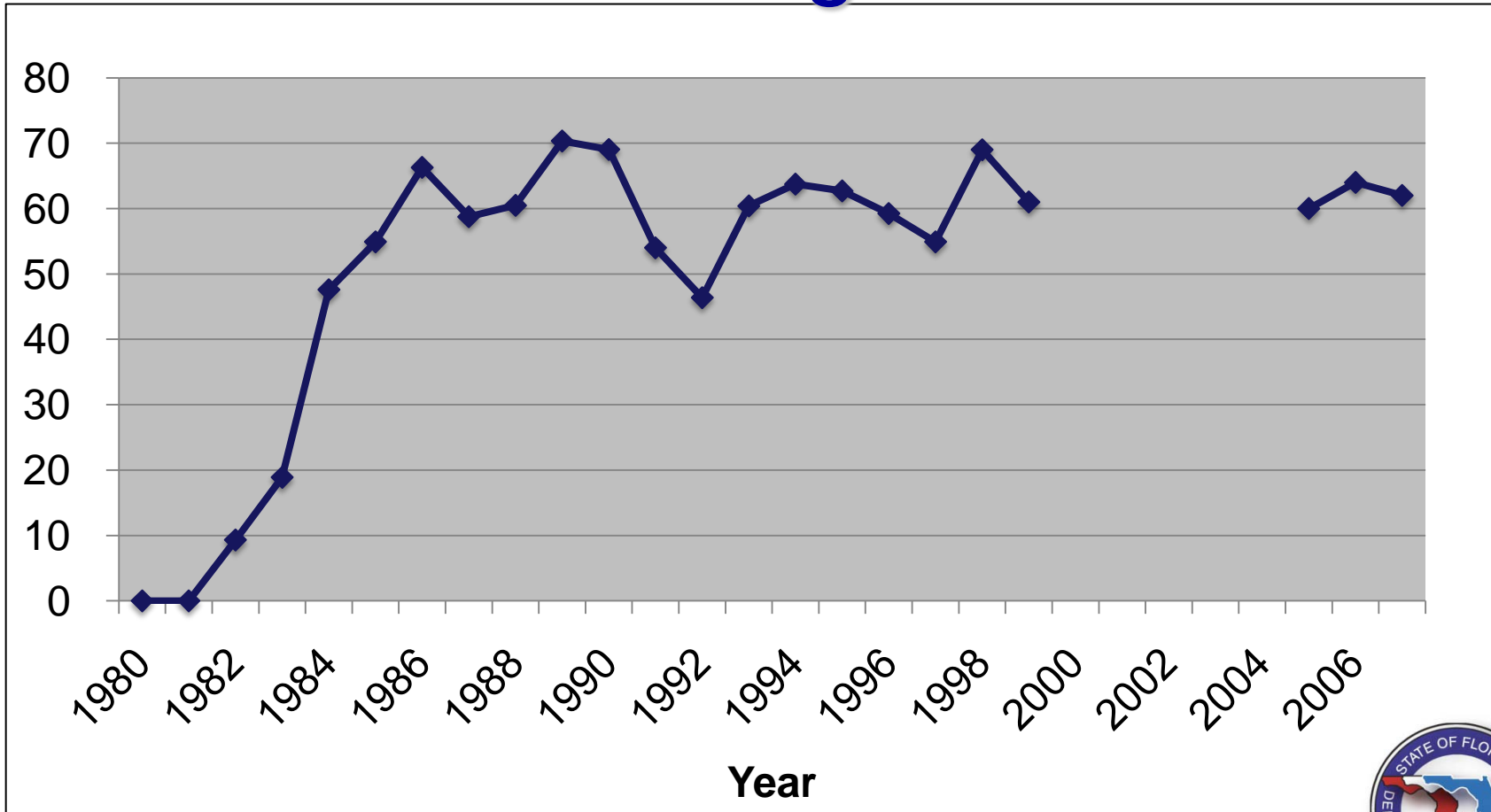
Quantities



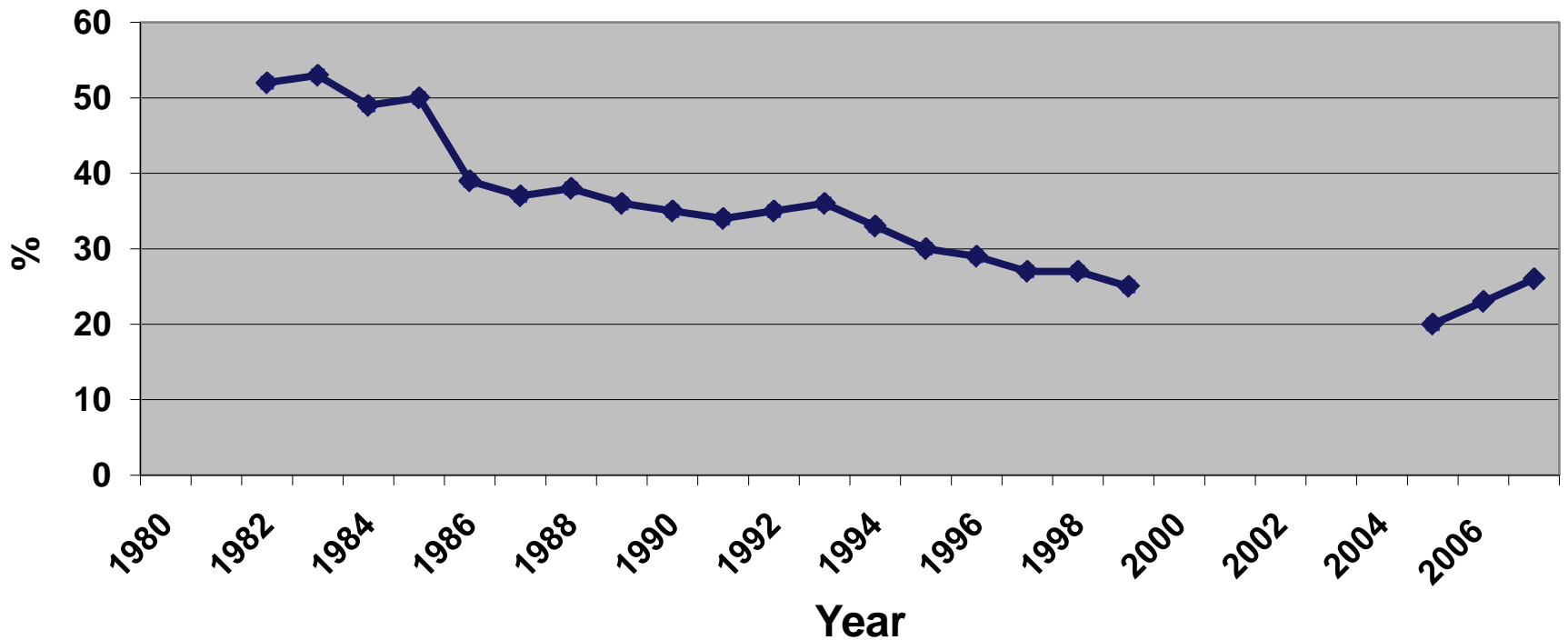
Total HMA



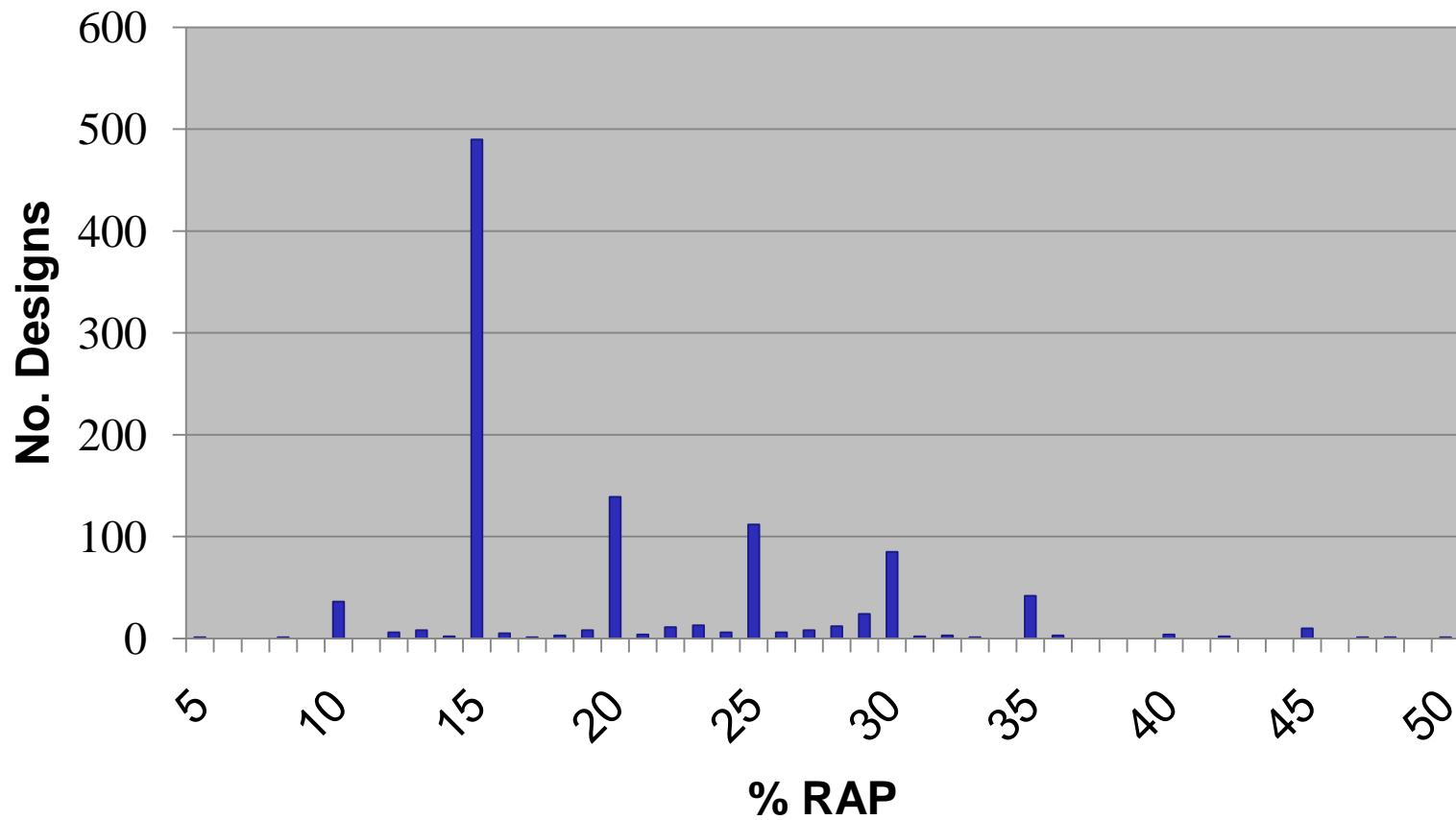
Percentage of HMA Mixes Containing RAP



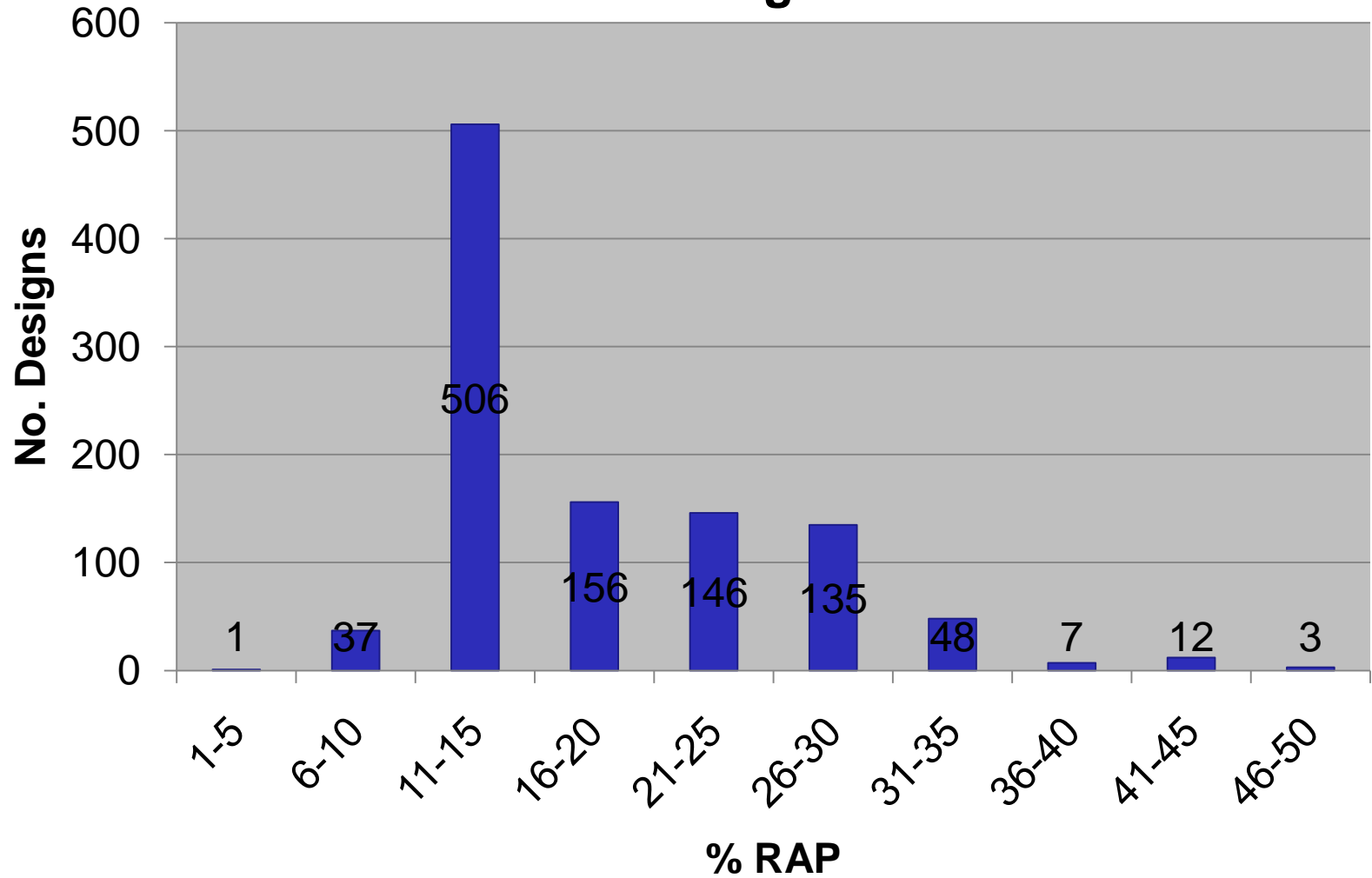
Average RAP Content



RAP Mix Designs

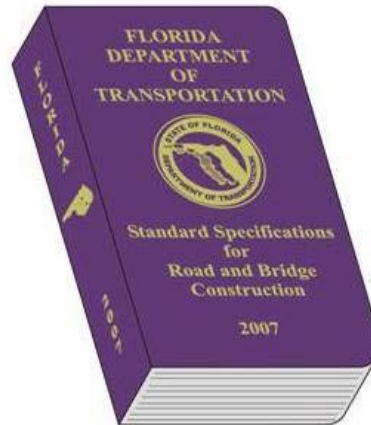


RAP Mix Designs



Why the weird distribution?

- FDOT specification restrictions
- Mix design requirements
- Production criteria



Specification Restrictions

Asphalt Binder Grade for Mixes Containing RAP

Asphalt Binder Grade	Percent RAP
PG 76-22	≤ 15
PG 67-22	< 20
PG 64-22	20 – 29
Recycling Agent (RA)	≥ 30



Mix Design

- Difficult to meet design criteria:
 - VMA
 - P_{-200}/P_{be}
- Use of Recycling Agents ☹
 - Recovered binder viscosity
 - 6,000 – 12,000 poises
 - Assume complete blending



Mix Production & Placement

- PWL Specification
 - Roadway density
 - Air Voids
 - Binder Content,
 - P_{-8}
 - P_{-200}
- Monitor recovered binder viscosity
 - 6000 – 12,000 poises



Other Limitations

- Not permitted in final wearing surface
 - Friction issue

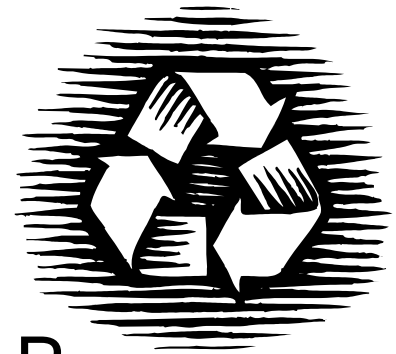


Benefits of Recycling

- Conserves resources
- Permits milling
- Saves money
- Politically correct 😊



Conserves Resources

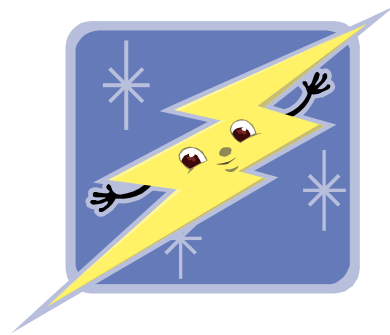


- 2007:
 - 6.3 million tons HMA
 - 62% of HMA mixes contained RAP
 - Average RAP content = 25%
 - Used 900,000 tons of RAP
 - 905,000 tons aggregate
 - 45,000 tons binder
- More available material = more roads



Conserves Energy

- It is estimated that the usage of 1 ton of HMA containing RAP conserves 200,000 BTU's of energy
 - Less aggregate to mine, process & deliver
 - Less asphalt to refine & deliver



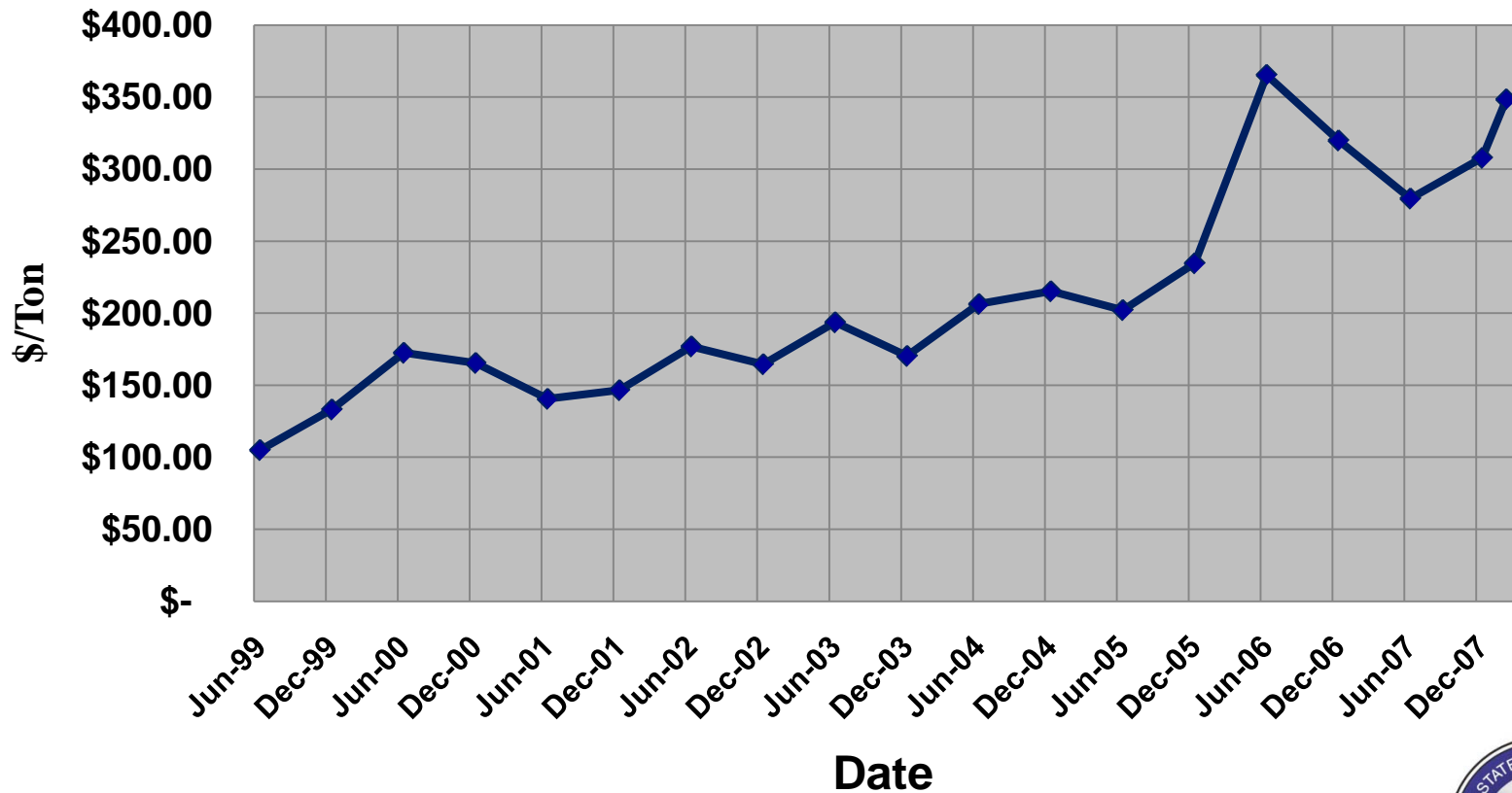
Saves Money

Current costs of aggregate, binder and hot mix asphalt are at an all time high

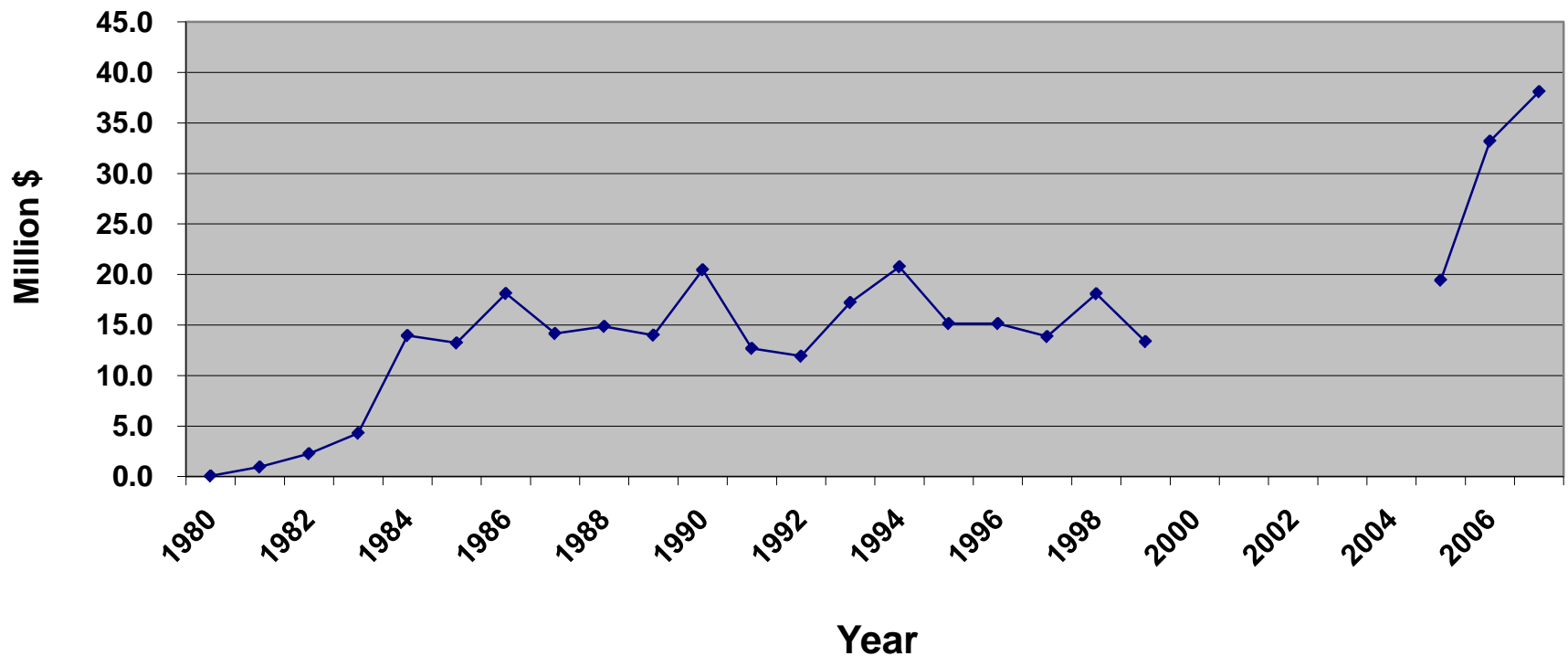
- Binder: >\$350/ton
- Aggregate: 18 – 23 \$/ton
- HMA: >\$100/ton



Cost of Asphalt Binder in Florida



Savings in Materials Costs



Performance



Performance Data: Where are we today?



	Deficient Pavements			
Criteria	2003	2004	2005	2006
Ride	2.6%	6.3%	3.8%	3.4%
Crack	15.8%	16.5%	15.8%	14.6%
Rut	1.5%	1.2%	0.9%	0.9%

Average time between resurfacings: ~17 years



Top Down Cracking





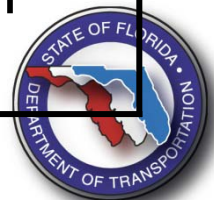
With ARB

Without ARB



Overdrive Magazine “Best Roads”

Rank	2003	2004	2005	2006	2007
1	Texas	Texas	Texas	Texas	Florida
2	Florida	Florida	Florida	Florida	Tenn
3	Tenn	Tenn	Tenn	Tenn	Texas
4	Georgia	Georgia	Georgia/ Ohio	Georgia	Georgia
5	Ohio	Ohio	Nevada/ Virginia	Virginia	Penn



Current RAP Use Practices

- Stockpiled millings ~ 15 - 20%
- Crushed/screened RAP
 - Typically 20 – 30%
 - Good virgin materials ~ 40%
- Fractionated RAP
 - 35 – 45%



Various Source RAP Pile...aka GOK RAP





Various Source RAP

RAP Crusher





Crushed RAP Pile





Fractionated RAP







FRAP
COARSE



FRAP
FINE



How can FDOT use more RAP?

- Look at specification limits
 - Reduce VMA for lower volume roads
- Allow up to 15% RAP in friction courses
- Encourage innovative technologies
 - Fractionated RAP
 - Warm Mix



Summary

- FDOT has had a successful HMA recycling program for over 25 years
- Recycling can help resolve some of the current material & cost related issues
- Quality of asphalt mixes containing RAP as good (or better) than conventional mixes
- FDOT working to increase RAP usage





Thank you...