RECYCLED ASPHALT PAVEMENT (RAP) IN THE GRAND FORKS DISTRICT.

2013 CONSTRUCTION CONFERENCE

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RAP? – WHAT ARE WE TALKING ABOUT?

1. RAP = Reclaimed Asphalt Pavement (FHWA)
2. RAP = Recycled Asphalt Pavement (NDDOT bid item)
3. RAP = Milled material (Anyone may reference this way)

So, be clear in communication, notes, correspondence, etc.

RECYCLED ASPHALT PAVEMENT (RAP) IN THE GRAND FORKS DISTRICT.

1. Reasons to use recycled asphalt.
2. Where do we get millings and why?
3. How do we obtain millings and why?
4. Characteristics of millings & RAP.
5. Design, Plan Notes, etc.
6. Mix Design and Verification process.
7. Plant/Lab operations and responsibilities using RAP in Hot Bituminous Pavement.
8. Economics
9. Number of tons of Recycled Hot Bituminous Pavement paved in the Grand Forks District since 2008.
10. Conclusions

1. REASONS TO RECYCLE

- Roadways have reached a critical width, slough and/or shoulder slope rate – the alternative is sliver widening, mine & blend or major widening.

- Conserving roadway material, conserving virgin aggregate sources/pits, viewing existing pavement as an asset.

- Incorporating millings into HBP is NOT wasting an expensive asset.
  - Previously, millings were used to make salvage base – is this a waste?
  - Thought exercise:
    - Deliver a pile of milled asphalt to use for salvage base or pure millings for use.
    - How much would it cost? Aggregate, asphalt cement, trucking, etc.

1. REASONS TO RECYCLE

- Eliminates problems with quantity estimates or yield calculations for irregular thicknesses used to fill existing pavement depressions (blade lay).

- Economics - price of AC - every 1% of AC at $500/ton saves you... ?

- For every mile of roadway milled, assuming 20% millings utilization and no millings wasted, 5 miles can be paved. Or, for every inch milled, we can pave five inches with RAP.

REASONS TO MILL

- Perpetual pavement concept.
- Remove depressed cracks, rutting, correct irregular cross slope.
- Provides efficient removal of deteriorated flexible pavement material that is unsuitable for retention in the pavement structure.
- Another chance to improve ride since it can restore both longitudinal and transverse grade with automatic grade control.
- Eliminate differential compaction problems.

REASONS TO MILL

- Curb and gutter lines are maintained or reestablished before overlays.
- Maintain clearances for bridge structures, traffic signals and overhead utilities by using this efficient removal technique.
- Provides millings for RAP operations. AC content is high from surface treatments in this surface layer.
- Provides a highly skid resistant surface suitable for temporary use by traffic until the final surface can be placed.

2. WHERE DO WE FIND MILLINGS AND WHY?

Grand Forks District projects:

- Used millings off of the same roadway or
- Adjacent project with excess millings.

County and City projects:

- Stockpiled millings from other projects from the contractor.

We've had the experience of using our own material; using other material may have a different outcome.

We know our material is generally good.

3. HOW DO WE OBTAIN MILLINGS AND WHY?

- Primarily From Cold Milling the Existing Pavement
- Contains valuable AC potential for cost savings.
- The price of milling has decreased, mostly because of larger quantities. The cost of AC has increased. Either economics are shifting or we didn't know because RAP wasn't tried much before.

3. HOW DO WE OBTAIN MILLINGS?

4. CHARACTERISTICS OF MILLINGS

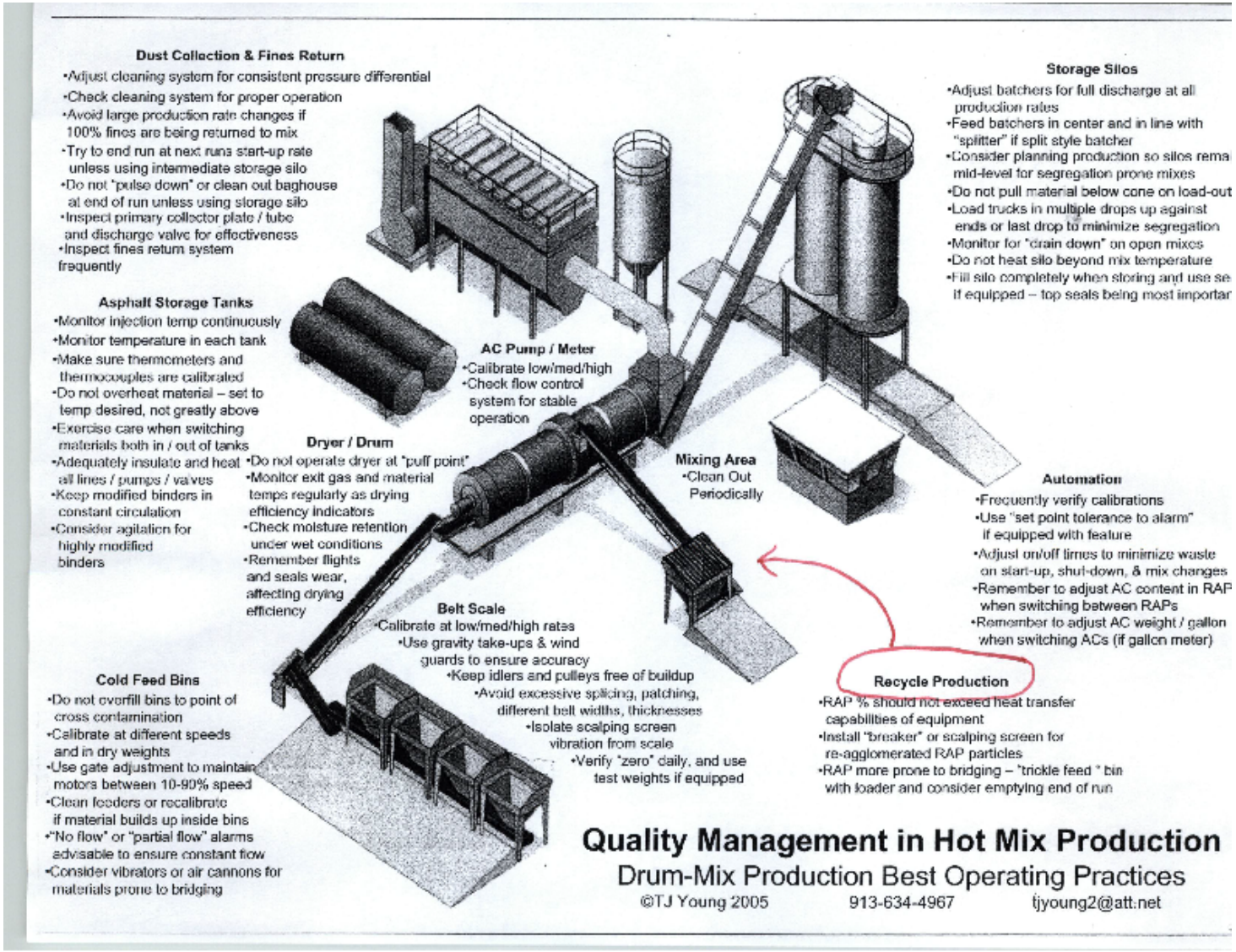
- Milled aggregate is generally high in Fine Aggregate Angularity and Coarse Aggregate Angularity – which is difficult to achieve without processing natural pit material.

- If the existing roadway from which the millings are obtained was constructed to NDDOT Specifications, the millings should be close to those gradations (usually slightly finer).
- Typically medium to high in material passing the #200

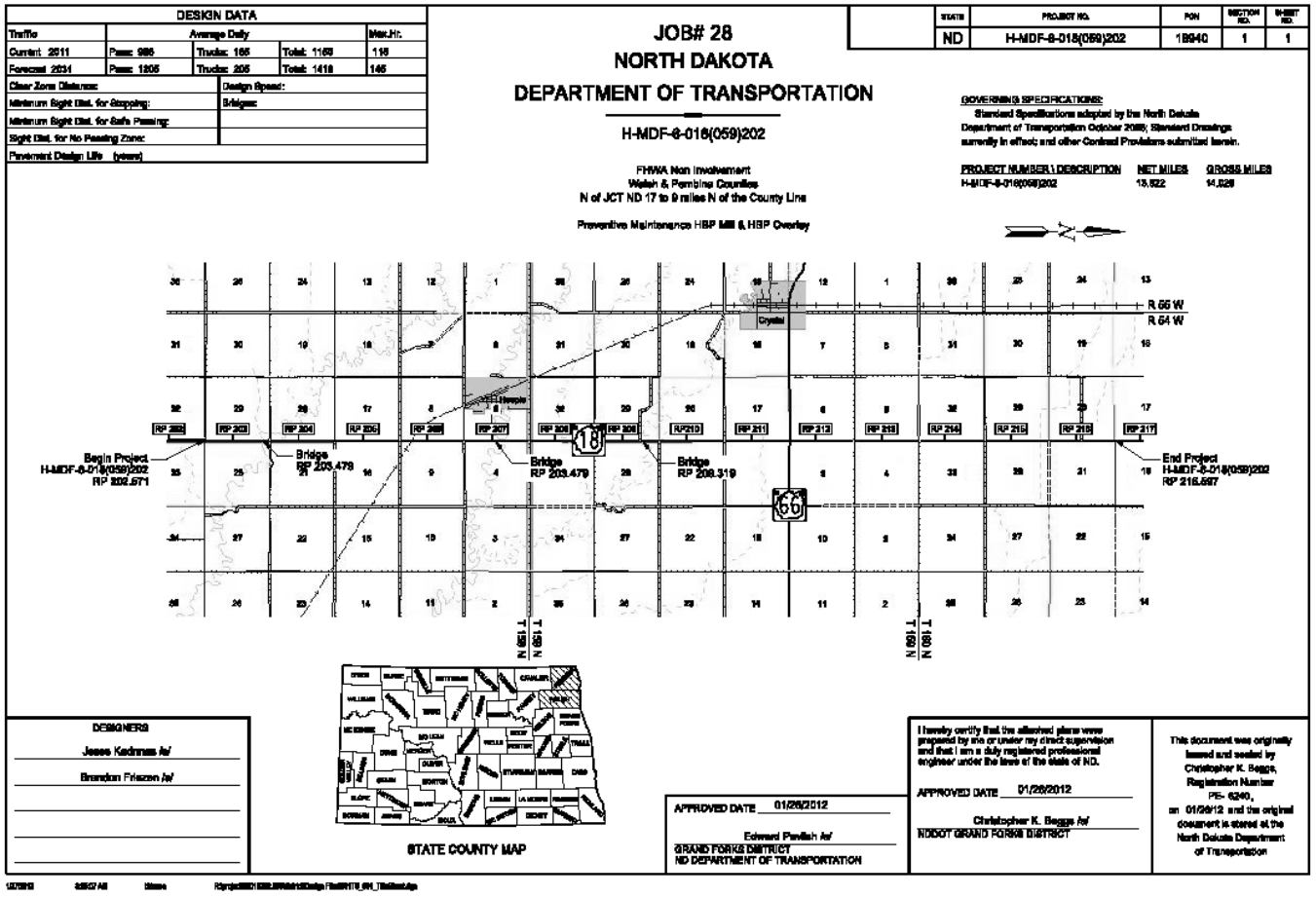
- Milling process causes some variability in gradation.

- See Curt's upcoming slides for AC content.

TYPICAL HOT MIX ASPHALT PLANT EQUIPPED FOR RAP



5. RECYCLED ASPHALT PAVEMENT PLAN DESIGN



DESIGN DATA

Traffic	Average Daily			Mat.Hr.
Current 2011	Pass: 986	Trucks: 165	Total: 1169	116
Forecast 2031	Pass: 1206	Trucks: 205	Total: 1418	146

Clear Zone Distance:	Design Speed:
Minimum Sight Dist. for Stopping:	Bridges:
Minimum Sight Dist. for Safe Passing:	
Sight Dist. for No Passing Zone:	
Pavement Design Life (years)	

STATE	PROJECT NO.	PCN	SECTION NO.	SHEET NO.
ND	H-MDF-8-018(059)202	19940	1	1

JOB# 28
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION
H-MDF-8-018(059)202

FHWA Non Involvement
Welsh & Pembina Counties
N of JCT ND 17 to 9 miles N of the County Line

Preventive Maintenance HBP Mill & HBP Overlay

GOVERNING SPECIFICATIONS:
Standard Specifications adopted by the North Dakota Department of Transportation October 2008; Standard Drawings currently in effect; and other Contract Provisions submitted herein.

PROJECT NUMBER \ DESCRIPTION	NET MILES	GROSS MILES
H-MDF-8-018(059)202	13.522	14.026

R 66 W
R 64 W
Crystal
Hoople
Begin Project H-MDF-8-018(059)202 RP 202.571
Bridge RP 203.479
Bridge RP 203.479
Bridge RP 208.319
End Project H-MDF-8-018(059)202 RP 216.597
T 159 N
T 160 N

STATE COUNTY MAP

DESIGNERS
Jesse Kadrmas /e/
Brandon Friezen /e/

APPROVED DATE 01/26/2012
Edward Pavlish /e/
GRAND FORKS DISTRICT
ND DEPARTMENT OF TRANSPORTATION

I hereby certify that the attached plans were prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the state of ND.
APPROVED DATE 01/26/2012
Christopher K. Beggs /e/
NDDOT GRAND FORKS DISTRICT

This document was originally issued and sealed by Christopher K. Beggs, Registration Number PE- 6240, on 01/26/12 and the original document is stored at the North Dakota Department of Transportation

RECYCLED ASPHALT PAVEMENT PLAN NOTES

410-P01 The recycled asphalt pavement (RAP) for this project (H-MDF-6-018(059)202) shall be obtained from the material produced by cold milling on this project (H-MDF-6-018(059)202).

410-P02 CONTRACTOR DEVELOPED MIX DESIGN: The contractor shall submit the Final Superpave Volumetric Mix Design. A mix design shall be submitted utilizing the RAP from Project H-MDF-6-018(059)202.

The aggregate source and bitumen target percentage shall be shown on the mix designs. The mix designs shall be submitted for approval 7 working days before the material is used.

RECYCLED ASPHALT PAVEMENT PLAN NOTES

410-P03 RECYCLED ASPHALT PAVEMENT–SUPERPAVE FAA 43: The contractor shall add 20 percent recycled asphalt pavement (RAP) in the Superpave FAA 43 mixture.

Job mix formula tolerances for RAP shall be ± 5 percent from the target value.

During mix production, the virgin aggregate shall meet the physical property requirements as determined from the mix design. The Initial Control Points for Superpave Aggregate may be waived.

RECYCLED ASPHALT PAVEMENT PLAN NOTES

410-P03 Continued

The mix design for mainline paving containing virgin and RAP material shall meet the requirements of Section 410 of the Standard Specifications.

RAP shall be processed so that the maximum particle size in the cold feed does not exceed1-1/2 inches.

RAP shall be introduced into the drum and combined with the virgin aggregate so the RAP does not come into direct contact with the burner flame. Asphalt binder shall be added to the mixture in the drum after the virgin aggregate and RAP have been combined.

RECYCLED ASPHALT PAVEMENT PLAN NOTES

410-P03 Continued

The contractor shall supply a 165 lb. sample of RAP milled from the project in addition to the virgin aggregate and liquid asphalt required in Section 410 for mix design verification purposes. The samples shall be submitted to the Grand Forks District.

RECYCLED ASPHALT PAVEMENT PLAN NOTES

410-P04 AGGREGATE AND MIX DESIGN PROPERTIES: The aggregate blend and properties shall meet the requirements outlined in Section 410 Superpave Volumetric Mix Design. The following aggregate and mix design properties are required:

TEST	CRITERIA	REFERENCE
Coarse Aggregate Angularity	75% min	NDDOT Field Sampling & Testing Manual
Fine Aggregate Angularity	43% min	AASHTO T 304
Gyratory Effort. #Gyration	N_{ini}=7, N_{des}=75, N_{max}=115	AASHTO R 35
Voids Filled With Asphalt	65-78%	AASHTO M 323, T 166
% G_{mm} @ N_{ini}	90.5% max	AASHTO M 323, T 166
Lightweight Pieces in Virgin Aggegate % Shale	5.0% max	AASHTO T 113, NDDOT Modified

RECYCLED ASPHALT PAVEMENT BID ITEMS

Bid Items:

Similar to a Regular HBP Project with one exception:

SPEC	CODE	ITEM
410	0247	RECYCLED ASHALT PAVEMENT – SUPERPAVE FAA 42

6. MIX DESIGN AND VERIFICATION PROCESS

Similar to Mix Designs containing all virgin aggregate with the following exceptions:

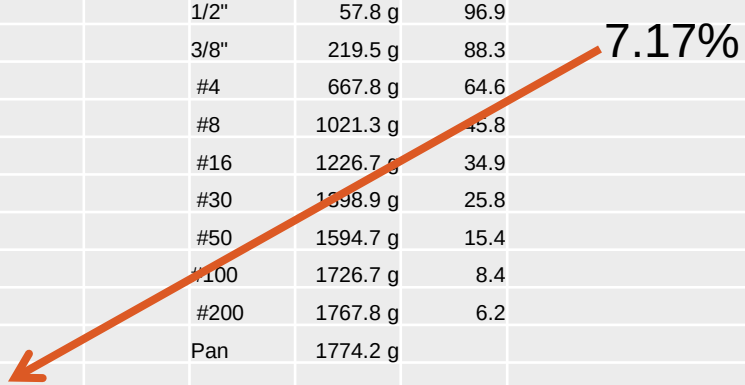
As per the plan notes we obtain a sample of RAP from the Contractor and is tested for verification of:

- **A/C content (Extraction)**
- **Gradation of the extracted sample**
- **Coarse Aggregate Angularity**
- **Fine Aggregate Angularity**
- **Specific Gravity**

Compare with Contractor's numbers

Mix Design and Verification process

EXTRACTED ASPHALT & GRADATION						
Pit			Test No.			
Project Number	ND 18		Mix Type		Rap	
Date Run	4/9/2012		Sample Date		4/6/2012	
MOISTURE CORRECTION			GRADATION			
Pan & Mix (Wet)	1468.7 g		Sieve Size	Cumul. Wt. Ret.	Percent Passing	
Pan & Mix (Dry)	1466.5 g					
Pan	267.2 g					
Mix (Wet)	1201.5 g		1"	0.0 g	100.0	
Moisture Loss	2.2 g		3/4"	0.0 g	100.0	
Moisture Correction	0.002		5/8"	0.0 g	100.0	
			1/2"	57.8 g	96.9	
EXTRACTION-ASPHALT			3/8"	219.5 g	88.3	
Mix (Wet)	2033.4 g		#4	667.8 g	64.6	
Moisture	3.7 g		#8	1021.3 g	45.8	
Mix (Dry)	2029.7 g		#16	1226.7 g	34.9	
Filter (Before)	18.9 g		#30	1398.9 g	25.8	
Filter (After)	20.9 g		#50	1594.7 g	15.4	
Agg & Celite	1918.3 g		#100	1726.7 g	8.4	
Celite	36.2 g		#200	1767.8 g	6.2	
Aggregate (Total)	1884.1 g		Pan	1774.2 g		
%AC (Mix Basis)	7.172 %					



EXAMPLE: DETERMINING % OF ASPHALT CONCRETE PROVIDED BY RAP

Contactor chooses to use 24% RAP in the composite Mix.

The extraction test result, on the preceding page, yielded approximately 7.2% AC in the RAP.

(7.2%) X (0.24) = 1.72 %

RAP will contribute approx. <u>1.72%</u> AC to Total Mix

Mix Design and Verification process

Pit #1 Location	Fordville
Pit #2 Location	
Pit #3 Location	

5.8%

Mix Properties at Recommended Asphalt Content

	Mix Design	Specification
Optimum AC (%)	5.8	
Density (pcf)	147.3	
Air Voids (%)	4.0	4.0
VMA (%)	14.3	14.0 min
VFA (%)	72.6	65-78
%Gmm @ Ninitial	88.2	90.5
%Gmm @ Nmaximum	96.1	98 max
AC Film Thickness (m)	10.0	7.5-13
Dust/Effective AC Ratio	1.0	.6-1.3
Fine Agg Angularity (%)	43.8	43
Sand Equivalent (%)	67.5	40min
Coarse Agg Angularity (%)	88.1	75
Flat/Elongated Pieces (%)	0.0	10 max

Maximum SpG @ Ndes	2.459
Frac. Faces Fine (%)	58.3
Frac. Faces Course (%)	89.3

Final Aggregate Blend (%)

27	Fordville	Rock
28	Fordville	fines
21	Fordville	Dust
24	ND 18	RAP

4.2%

Remarks:

Add Ac is 4.2%

Gyratory Compactive Effort

Ninitial	7
Ndesign	75
Nmaximum	115

Summary of Aggregate Characteristics from Mix Design

Gradation (% passing)	
5/8"	100.0
1/2"	92.5
3/8"	76.3
#4	55.7
#8	39.8
#16	27.6
#30	16.8
#50	9.5
#100	6.6
#200	5.0

Asphalt Absorption (%)	1.05
Water Absorption (%)	1.68
Light Wt Particles (%)	4.0
Toughness (% Loss)	

Specific Gravity Information

Bulk (Gsb)	2.555
Apparent (Gsa)	2.702
Effective (Gme)	2.623

7. PLANT/LAB OPERATIONS AND RESPONSIBILITIES USING RAP IN THE HOT BITUMINOUS PAVEMENT

MILLING OPERATIONS AT THE PROJECT

RAP BEING MILLED AND LOADED FOR TRANSPORT BACK TO THE PLANT

STOCKPILING RAP AT PLANT SITE

CLOSE-UP OF RAP MATERIAL

STOCKPILE OF RAP

RAP BEING MOVED FROM THE STOCKPILE TO THE PLANT

RAP BEING DUMPED INTO A HOPPER PRIOR TO BEING SCREENED FOR OVERSIZE

HOPPER FILLED WITH RAP

RAP PROCESSED FOR OVERSIZE

RAP BEING TRANSPORTED TO DRUM DRYER

VIEW OF THE RAP COLLAR

ANOTHER VIEW OF RAP COLLAR

RECYCLED ASPHALT PAVEMENT LEAVING THE PLANT

7. LAB RESPONSIBILITIES

COMPOSITE GRADATION VERSES VIRGIN GRADATION

JOB MIX FORMULA

AGGREGATE GRADATION & PROPERTIES

			Fordville	Fordville		Fordville				
Product	Rap	Shingles	fines	5/8"		D.Dust			Composite	Virgin
Proportion	24	0	27	28	0	21	0	0	Gradation	Gradation
3/4"	100.0	0.0	100.0	100.0	0.0	100.0	0.0	0.0	100.0	100.0
5/8"	100.0	0.0	100.0	100.0	0.0	100.0	0.0	0.0	100.0	100.0
1/2"	97.0	0.0	100.0	75.0	0.0	100.0	0.0	0.0	92.3	90.8
3/8"	87.0	0.0	100.0	26.0	0.0	100.0	0.0	0.0	76.2	72.7
No 4	63.0	0.0	80.0	1.2	0.0	81.0	0.0	0.0	54.1	51.2
No 8	45.0	0.0	62.0	1.0	0.0	50.0	0.0	0.0	38.3	36.2
No 16	33.0	0.0	40.0	1.0	0.0	31.3	0.0	0.0	25.6	23.2
No 30	24.0	0.0	17.0	1.0	0.0	21.8	0.0	0.0	15.2	12.4
No 50	14.0	0.0	7.0	1.0	0.0	15.6	0.0	0.0	8.8	7.2
No 100	9.0	0.0	5.0	1.0	0.0	11.5	0.0	0.0	6.2	5.3
No 200	6.3	0.0	4.1	1.0	0.0	8.8	0.0	0.0	4.7	4.3
%Crush 1F	88.0	0.0	10.0	94.0	0.0	100.0	0.0	0.0	83.5	88
%Crush 2F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
FAA	46.0	0.0	40.5	47.5	0.0	47.5	0.0	0.0	44.1	43.9
-#4 Gsb	2.606	0.000	2.462	2.651	0.000	2.521	0.000	0.000	2.522	
+#4 Gsb	2.606	0.000	2.484	2.651	0.000	2.524	0.000	0.000	0.000	
Comb. Gsb	2.606	0.000	2.466	2.651	0.000	2.522	0.000	0.000	2.561	
Gsa/Abs%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

CUT OFF REPORT

A CUT OFF REPORT IS COMPLETED FOR A RECYCLED ASPHALT PROJECT JUST AS IT IS FOR A HBP PROJECT W/O RAP.

NDDOT PAYS FOR THE TONNAGE OF HBP PRODUCED BUT ONLY PAYS FOR THE VIRGIN OR ADDED AC

PAVING OPERATIONS

PAVING RECYCLED HOT MIX ASPHALT

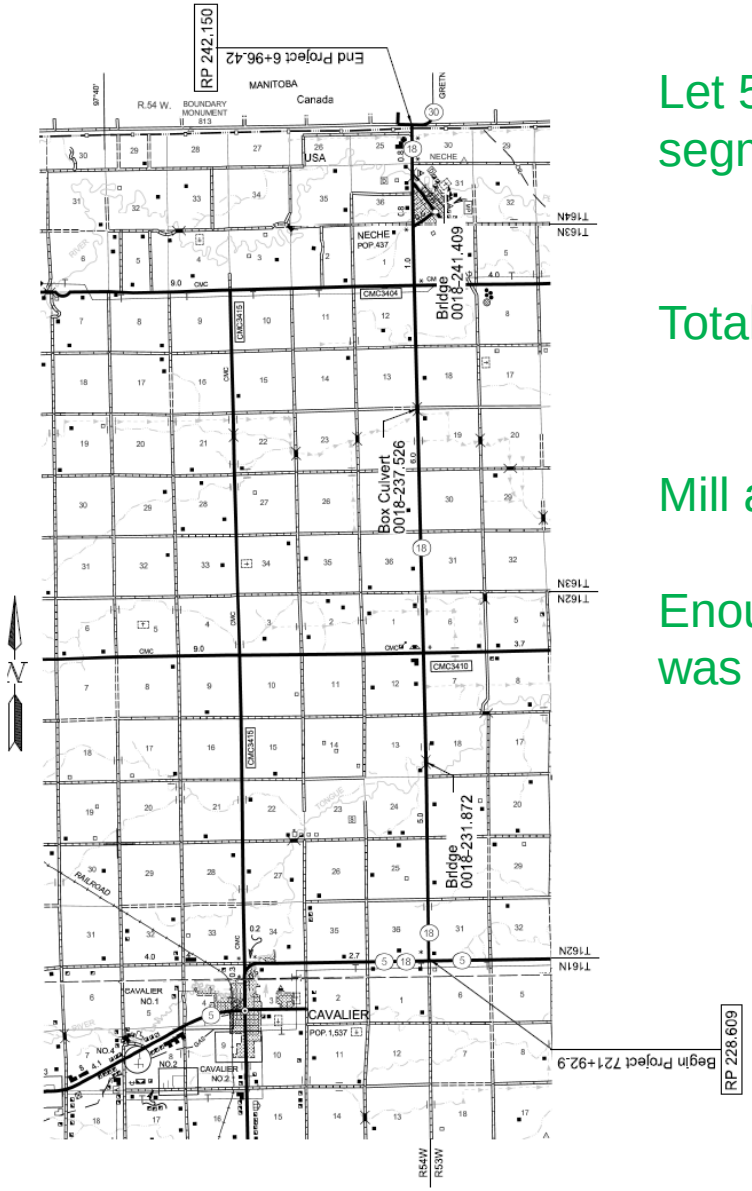
8. ECONOMICS OF RAP:

“I'm not an economist and we all know economists were created to make weather forecasters look good.”

-Rupert Murdoch

Here’s an example…

ND 18 AND ND 5 - TIED



Let 5/20/2011 – Segment shown below and segment of ND 5 from Cavalier to US 81.

Total of 21.7 Miles

Mill and overlay was chosen due to width.

Enough millings were available, the roadway was paved with RAP.

ND 18 AND ND 5 - TIED

12/12/2012

North Dakota Department of Transportation
Progressive Estimate Details

Project: SCB-6-005(026)314 PCN: 17843 Date Submitted For Payment: 07/30/2012 Letting Date: 05/20/2011
SubProject: 1 PREVENTIVE MAINTENANCE HBP OVERLAY

Spec. No.	Code No.	C.O. No.	Description	Original Quantity	Unit	Unit Price	BID Amount	QUANTITIES Current	QUANTITIES Total to Date	AMOUNT Current	AMOUNT Toal to Date	Projected Quantity
Bid Items and Change Orders												
103	100		CONTRACT BOND	0.400	L SUM	11,500.000	4,600.00	0.077	0.400	885.50	4,600.00	100.00
230	125		SHOULDER PREPARATION	16.300	MILE	280.000	4,564.00		16.300		4,564.00	100.00
302	100		SALVAGED BASE COURSE	225.000	TON	20.000	4,500.00		662.120		13,242.40	294.28
401	150		SS1H OR CSS1H OR MS1 EMULSIFIED ASPH	13,156.000	GAL	2.000	26,312.00		14,130.000		28,260.00	107.40
410	250		RECYCLED ASPHALT PAVEMENT-SUPERPA	23,317.000	TON	37.100	865,060.70	0.180	23,205.360	6.68	860,918.86	99.52
410	445		PG 58-28 ASPHALT CEMENT	1,169.000	TON	448.000	523,712.00		998.440		447,301.12	85.41
410	910		CORED SAMPLE	51.000	EA	15.000	765.00		93.000		1,395.00	182.35
411	105		MILLING PAVEMENT SURFACE	1,650.000	SY	0.750	1,237.50		2,422.010		1,816.51	146.79

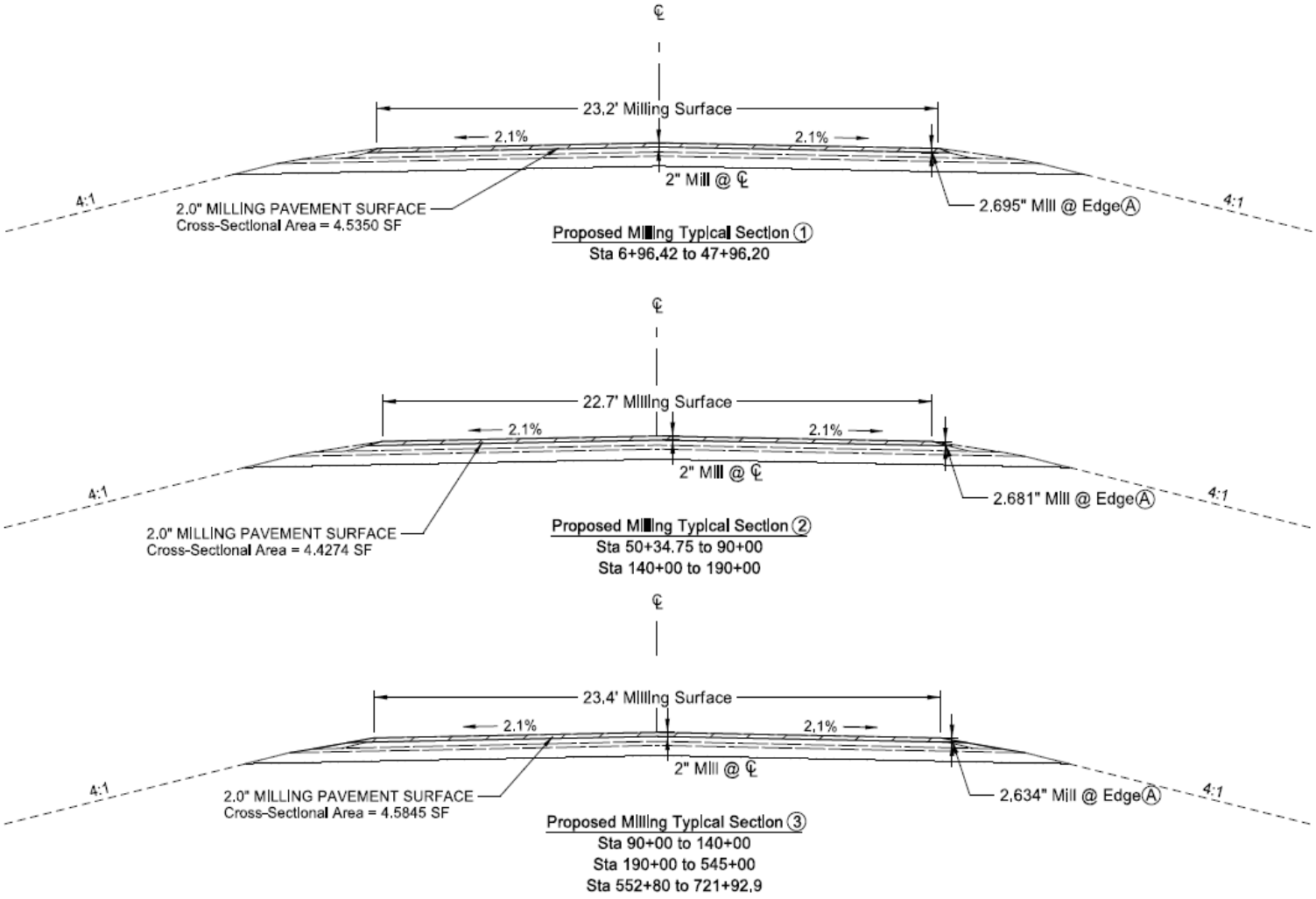
Project: SCB-6-018(052)228 PCN: 17134 Date Submitted For Payment: 07/30/2012 Letting Date: 05/20/2011
SubProject: 1 MILL & OVERLAY, ATR INSTALLATION, PAVEMENT MARKING, & INCIDENTALS

Spec. No.	Code No.	C.O. No.	Description	Original Quantity	Unit	Unit Price	BID Amount	QUANTITIES Current	QUANTITIES Total to Date	AMOUNT Current	AMOUNT Toal to Date	Projected Quantity
Bid Items and Change Orders												
103	100		CONTRACT BOND	0.600	L SUM	11,500.000	6,900.00	0.115	0.600	1,322.50	6,900.00	100.00
104	1	1	PRIMVE CONTRACTOR MARKUP	1.000	L SUM	3,278.180	3,278.18	0.024	0.919	78.68	3,012.65	91.90
104	2	2	PRIME CONTRACTOR MARKUP	1.000	L SUM	912.920	912.92		1.000		912.92	100.00
104	3	3	Prime Contractor Markup	1.000	L SUM	2,952.470	2,952.47		1.000		2,952.47	100.00
202	330	2	REMOVAL OF RAILROAD RAIL	1.000	L SUM	9,129.170	9,129.17		1.000		9,129.17	100.00
203	103	1	COMMON EXCAVATION-TYPE C	120.700	CY	19.200	2,317.44		120.000		2,304.00	99.42
203	109	1	TOPSOIL	84.200	CY	14.500	1,220.90		84.000		1,218.00	99.76
203	119	1	TOPSOIL-IMPORTED	51.100	CY	23.100	1,180.41					
203	130	1	MUCK EXCAVATION	300.000	CY	18.750	5,625.00		280.000		5,250.00	93.33
203	140	1	BORROW-EXCAVATION	358.200	CY	24.300	8,704.26		400.000		9,720.00	111.67
230	109	3	RESHAPING INSLOPE	1.000	L SUM	31,800.000	31,800.00		1.000		31,800.00	100.00
230	125		SHOULDER PREPARATION	27.000	MILE	280.000	7,560.00		27.000		7,560.00	100.00
302	100		SALVAGED BASE COURSE	152.000	TON	20.000	3,040.00		171.100		3,422.00	112.57
401	150		SS1H OR CSS1H OR MS1 EMULSIFIED ASPH	21,026.000	GAL	2.000	42,052.00		22,238.000		44,476.00	105.76
410	250		RECYCLED ASPHALT PAVEMENT-SUPERPA	25,760.000	TON	37.100	955,696.00		26,231.860		973,202.01	101.83
410	445		PG 58-28 ASPHALT CEMENT	1,289.000	TON	448.000	577,472.00		1,119.809		501,674.43	86.87
410	910		CORED SAMPLE	156.000	EA	15.000	2,340.00		156.000		2,340.00	100.00
411	105		MILLING PAVEMENT SURFACE	188,124.000	SY	0.750	141,093.00	-1,866.175	215,405.700	-1,399.63	161,554.28	114.50

ND 18 AND ND 5 - TIED

2” Milling, variable widths – 189,774 SY Plan; 217,055 SY Actual (15% over due to width variations).

Unit Price = $0.75 / SY; actual milling cost of $163,976 for both projects.



ND 18 AND ND 5 - TIED

2” RAP Superpave FAA 45 – 49,077 Tons (Plan)

– 49,436 Tons (Actual)

AC = PG 58-28 – 2,458 Tons (Plan) = 5.0%

– 2,118 Tons (Actual) = 4.3%

added oil.

Non-RAP HBP would generally be 6.1% or 2,994 Tons of AC

6.1%- 4.3% = 1.8% AC savings.

2,994-2,118 tons = 876 tons AC saved

876 x $448/ton AC = $392,448

ND 18 AND ND 5 - TIED

Comparing $392,448 savings on AC vs. milling cost of $163,976.

Benefit to Cost ratio of 2.4:1.

Or, $228,472 difference / 21.7 miles = $10,529 savings per mile.

Or, $228,472 / $2,783,096 or 8.2% savings based on mix cost.

Or, $228,472 / $2,947,072 or 7.7% savings based on mix plus milling costs.

Again, keep in mind milling was 15% over plan, HBP was 300+ ton over plan, etc.

Not included in savings analysis is using excess millings from this tied project to pave ND 1 with RAP, resulting in AC savings on that project.

ND 18 AND ND 5 - TIED

Combining AC and RAP Superpave bid items =

$56.30 per Ton of mix on this project

Could argue the contractor is “adjusting” bid price:

- Putting milling dollars in mix prices?
- Lowering AC price anticipating not using plan AC?
- Mobilization? – not bid differently on this project.

ND 18 AND ND 5 - TIED

408	445	PG 58-28 ASPHALT CEMENT	45,073.72	$23,375,280.24	$518.60	TON
408	450	PG 58-34 ASPHALT CEMENT	1,767.80	$1,348,571.00	$762.85	TON
408	475	PG 58-28 ASPHALT CEMENT-WMA ADDITIVE	559.00	$320,178.43	$572.77	TON
408	600	PG 64-28 ASPHALT CEMENT	1,794.80	$1,155,939.60	$644.05	TON
408	800	SUPERPAVE FAA 40	5,160.00	$357,101.16	$69.21	TON
408	802	SUPERPAVE FAA 42	103,947.00	$2,860,865.56	$27.52	TON
408	803	SUPERPAVE FAA 43	28,512.00	$810,672.00	$28.43	TON
408	805	SUPERPAVE FAA 45	34,215.00	$1,689,898.77	$49.39	TON
408	823	SUPERPAVE FAA 43-WMA	9,318.00	$222,141.12	$23.84	TON
408	1230	HOT BIT PAVEMENT CRACK CLEANING & SEALING	30,000.00	$19,500.00	$0.65	LF
408	1510	PAVEMENT REPAIR ALL DEPTHS	29.00	$725.00	$25.00	SY
408	1512	PAVEMENT REPAIR	185.00	$36,100.00	$195.14	TON
408	9605	CORED SAMPLE-BITUMINOUS PAVEMENT	1,550.00	$60,230.56	$38.86	EA
409	445	PG 58-28 ASPHALT CEMENT	75.00	$40,125.00	$535.00	TON
410	210	SUPERPAVE FAA 40	20,084.00	$440,241.28	$21.92	TON
410	212	SUPERPAVE FAA 42	139,056.00	$4,278,938.00	$30.77	TON
410	213	SUPERPAVE FAA 43	249,930.00	$7,313,077.90	$29.26	TON
410	215	SUPERPAVE FAA 45	763,867.80	$26,894,971.60	$35.21	TON
410	223	SUPERPAVE FAA 43-WMA	18,317.00	$552,759.20	$30.18	TON
410	248	RECYCLED ASPHALT PAVEMENT-SUPERPAVE FAA	26,703.00	$910,572.30	$34.10	TON
410	250	RECYCLED ASPHALT PAVEMENT-SUPERPAVE FAA	72,210.00	$2,697,497.40	$37.36	TON
410	445	PG 58-28 ASPHALT CEMENT	54,652.48	$28,840,032.99	$527.70	TON

2011 Annual Avg. Bid Price (AABP) for non-RAP FAA 45 HBP

- 6.1% x $527.70 + $35.21 / Ton = $67.40 / Ton of Mix
- 4.3% x $527.70 + $35.21 / Ton = $57.91 / Ton of Mix

vs. $56.30 on ND 18 & 5 for RAP.

Dollar values are even higher if 408 AABP are used, probably due to smaller quantities.

9. ACTUAL QUANTITIES OF RAP IN THE GRAND FORKS DISTRICT SINCE 2008 (18 PROJECTS):

	PROJ.	TONS HBP	TONS AC	% AC	AC UNIT $	MILLING COST
2008						
	SBI-6-029(071)197	59,932	2,694	4.50%	$460	$136,316
2009						
	SNH-6-017(029)127	46,214	2,058	4.45%	$460	$100,536
	SCB-SIM-6-017(027)137	6,862	314	4.58%	$460	$23,894
	AC-SBI-6-029(063)203	35,303	1,497	4.24%	$525	$76,089
	AC-SBI-6-029(073)205	59,128	2,506	4.24%	$525	$240,869
2010						
	SNH-6-002(071)300	18,125	830	4.58%	$352	$68,257
	SS-6-032(036)112	12,319	555	4.51%	$517	$55,678
	STM-SS-6-066(016)124	26,246	938	3.57%	$352	$127,012
	STM-SS-6-066(017)093	12,121	576	4.75%	$352	$0
	STM-SS-6-066(018)103	23,200	1,025	4.42%	$352	$1,196
	STM-SS-6-066(019)112	28,009	1,006	3.59%	$352	$1,137
2011						
	SS-RSS-6-001(026)162	45,983	2,241	4.87%	$400	$4,880
	SCB-6-005(026)314	23,205	998	4.30%	$448	$1,816
	SCB-6-018(052)228	26,232	1,120	4.27%	$448	$161,554
	SCB-6-032(045)219	25,995	1,085	4.17%	$448	$190,697
2012						
	SS-6-001(029)181	49,018	2,071	4.22%	$466	$116,973
	SS-MDF-6-017(038)077	6,526	272	4.17%	$466	$39,951
	H-MDF-6-018(059)202	26,439	1,075	4.07%	$458	$112,010
	TOTALS	530,857	22,861			$1,458,865
				4.31%	$445	

MONEY SAVED:

530,857 tons of RAP HBP used 22,861 tons of AC (4.31% avg.).

AC used would've been 32,382 tons at 6.1%, which is a typical AC content of non-RAP HBP in Grand Forks District.

32,382 - 22,861 = 9,521 Tons of AC saved.

$445 was the weighted average of the AC cost for all RAP projects.

9,521 Tons AC x $445 =	$4,237,495 in oil savings.
9,521 Tons AC x $528 (2011 AABP) =	$5,027,088 in oil savings.
Milling cost =	$1,458,865.

Difference = $2,778,630 to $3,568,223 in savings

(oil savings minus milling).

10. CONCLUSIONS:

Imagine savings if AC was bid more expensively (currently $550 avg.).

Contractors save aggregate processing:

- Less royalty pavements
- Approx. 20% less material to crush/process from the pit.

Contractors economically backhaul the millings to the plant.

Other comparisons not yet made:

- Consider IRI differences – expected to be better after mill & overlay vs. overlay only.
- Calculate the cost of the alternative – grade widening and the associated environmental documentation.

ND 18 won NAPA award for quality in construction for under 50,000 tons.

We’re not omitting downsides – we haven’t yet experienced any.

QUESTIONS?

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