

# Full Depth Reclamation the Le Sueur County Experience

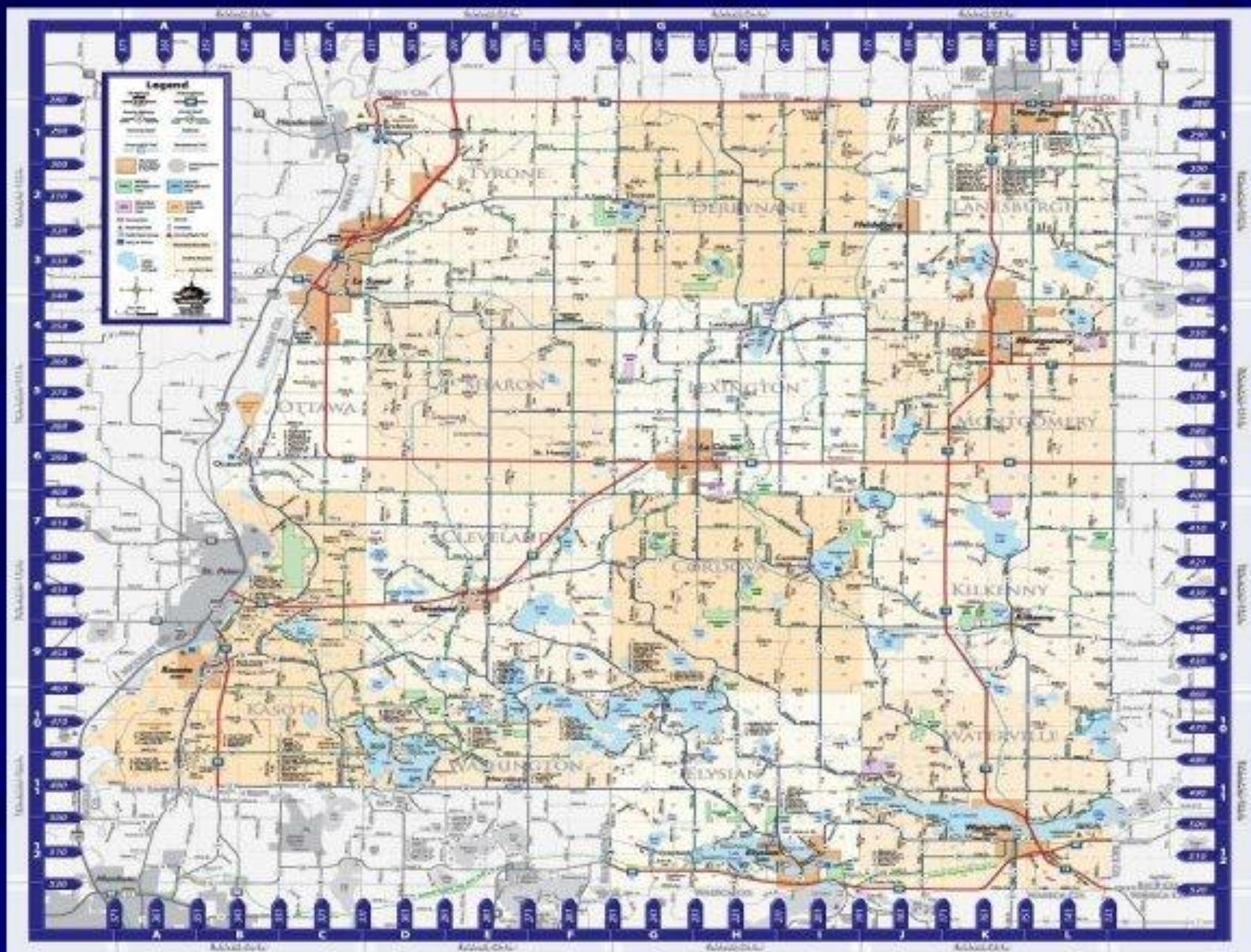
Darrell Pettis P.E.  
Le Sueur County Highway Engineer



# Le Sueur County, Minnesota

- **County Highway System Consists of:**
  - 267 miles of County State Aid Highways (CSAH).
  - 239 miles of County Roads (CR).
  - Total of 506 miles
- **About 300 miles are paved and 206 miles are aggregate surfaced.**







# Agenda for Presentation

## ■ 2008 FDR Projects

- County State Aid Highway 2
- County State Aid Highway 13
- County State Aid Highway 24

## ■ Lessons Learned

# CSAH 2 Existing Conditions

- Project Length of 4.79 miles
- 480 AADT (2007)
- Reconstructed in 1976
- Surfaced with 7" of P.M. Bituminous in 1979
- 3/4" Overlays in 1989 & 1995
- Springtime load posted at 7 tons per axle

# CSAH 2 Full Depth Patch





# CSAH 2 Edge Cracking





# CSAH 2 “Crows Feet”



# 2007 Pavement Condition Data

- PSR 2.7 to 3.1
- SR 2.6 to 2.8
- PQI 2.6 to 2.9
- IRI 77 in/mi to 137 in/mi



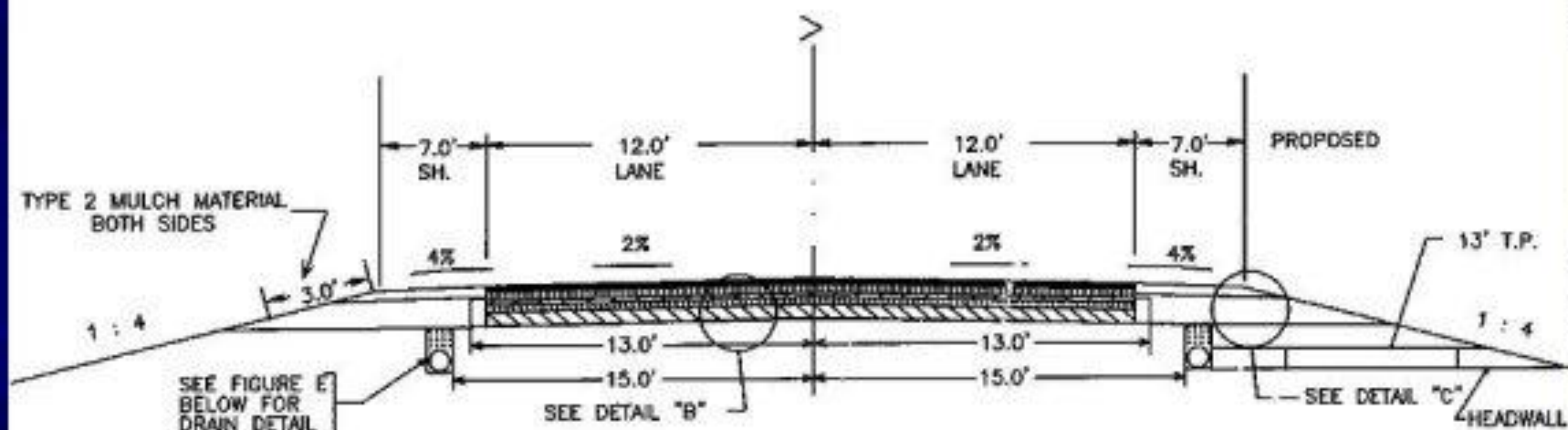
# CSAH 2 FWD Data Analysis

|            | Summary of Analysis Results |       |       |        |                            |     |          |      |
|------------|-----------------------------|-------|-------|--------|----------------------------|-----|----------|------|
|            | IRI <sub>20</sub>           | Eng   | Eff.  | E.O.E. | Axle Load for Design Defl. |     |          | TONN |
|            |                             |       |       |        | Tons                       |     |          |      |
|            |                             |       |       |        | AASHTO                     | SF  | Inv. 183 |      |
|            | mils                        | psi   | R-val | inches |                            |     |          | Tons |
| Avg. =     | 68.8                        | 5,995 | 9.3   | 19.3   | 8.8                        | 9.1 | 7.4      | 7.3  |
| Median =   | 65                          | 5,834 | 8.9   | 20.7   | 8.8                        | 9.1 | 7.5      | 6.9  |
| Std.Dev. = | 26.4                        | 1,596 | 2.9   | 5.7    | 2.0                        | 2.1 | 1.6      | 2.2  |
| 85th % =   | 45.9                        | 4,410 | 6.4   | 11.9   | 6.5                        | 6.8 | 5.5      | 5.1  |

# Proposed Typical Section

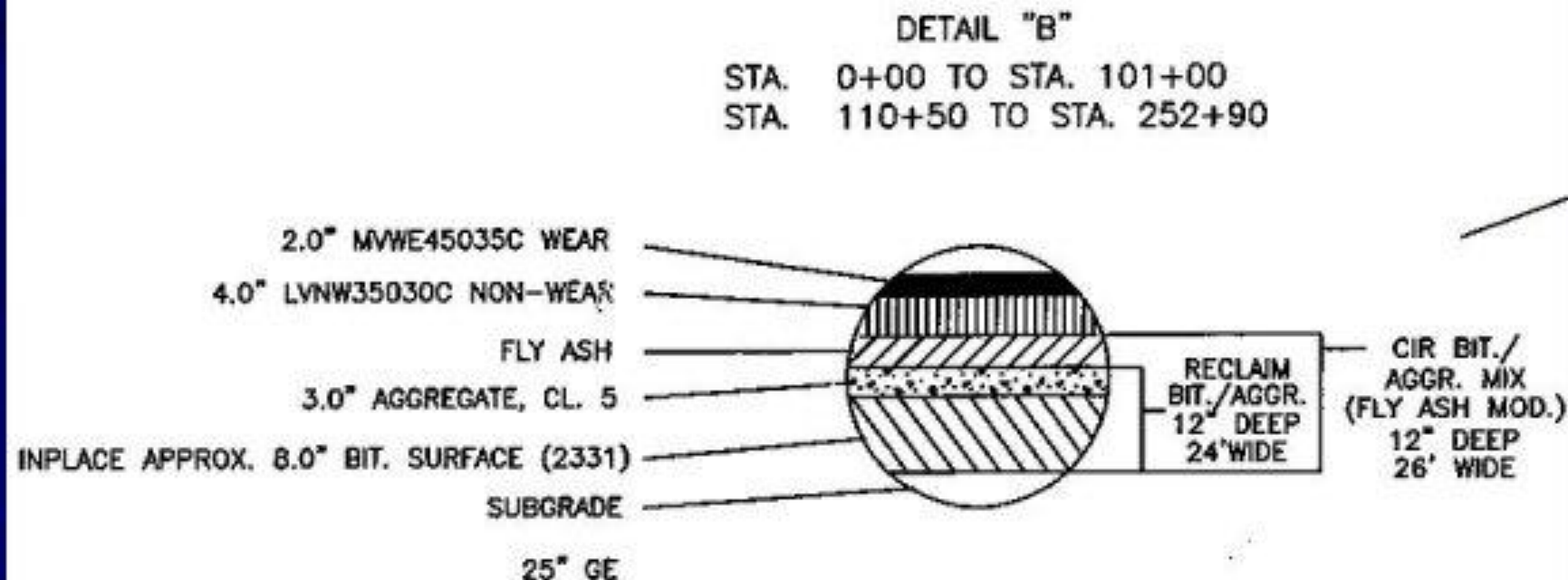
## CSAH 2 RECLAIM, CIR & OVERLAY SURFACING SECTION

STA. 0+00 TO STA 101+00  
STA. 110+50 TO STA 252+90  
24' BITUM. INP. - 24' OVERLAY  
10 TON DESIGN





# Typical Section Pavement Detail



# CSAH 2 Design

- Edge Drain Tile
- Reclaim 8" of existing Bituminous Pavement (Pre Grind)
- Add 3" of Aggregate Material
- Reclaim 12" Bituminous / Aggregate Mixture with 6% Class C Fly Ash
- Place a 6" bituminous surface

# CSAH 2 Reclaiming Existing 8" Bituminous Pavement





# CSAH 2 (Pre Grind)



# CSAH 2 Initial FDR





# 3" of Additional Aggregate Material





# CSAH 2



# CSAH 2 Blade and Compact the 3" of new Aggregate



# CSAH 2 Surface Prior to 2<sup>nd</sup> FDR and Fly Ash





# CSAH 2 Soft, Wet and non compacted Areas



# Vane Spreader for Fly Ash



# Transferring Fly Ash from Tanker Truck to Van Spreader





# CSAH 2 Fly Ash on the Base Material



# Fly Ash





# Mixing Fly Ash, Aggregate Material and Reclaimed RAP





# Reclaimed Material



# Compaction Equipment





# Steel Drum and Water Truck





# Compaction Equipment and Motor Patrol with Rubber Tired Roller



# Finish Rolling





# CSAH 2 Stabilized Base



# CSAH 2 Stabilized Base and First Lift of Bituminous Non-Wear





| Spec Number | Item                                         | Unit     | Estimated Quantities | Bid Price   | Amount         |
|-------------|----------------------------------------------|----------|----------------------|-------------|----------------|
| 2021.501    | Mobilization                                 | Lump Sum | 1                    | \$18,000.00 | \$18,000.00    |
| 2051.501    | Maint & Restoration of Haul Roads            | Lump Sum | 1                    | \$ 1.00     | \$1.00         |
| 2104.505    | Remove Bituminous Pavement                   | Sq Yd    | 4,328                | \$ 2.40     | \$10,387.20    |
| 2104.513    | Saw Bituminous Pavement                      | Lin Ft   | 100                  | \$ 4.00     | \$400.00       |
| 2112.501    | Subgrade Preparation                         | Rd Sta   | 9.5                  | \$ 150.00   | \$1,425.00     |
| 2221.501    | Aggregate Shouldering, Class 1               | Ton      | 15,000               | \$ 11.00    | \$165,000.00   |
| 2232.501    | Mill Bituminous Surface                      | Sq. Yd.  | 70                   | \$ 5.00     | \$350.00       |
| 2321.506    | Aggregate - Class 5                          | Ton      | 9,900                | \$ 9.00     | \$89,100.00    |
| 2331.604    | Reclaim Bituminous Surface & Aggre 12" depth | Sq Yd    | 64,907               | \$ 1.15     | \$74,643.05    |
| 2331.604    | CIR Bit. / Aggr. Mix Fly Ash Mod 12" depth   | Sq Yd    | 70,315               | \$ 1.00     | \$70,315.00    |
| 2331.609    | Fly Ash for Cold Mix, Class C                | Ton      | 2,570                | \$ 60.00    | \$154,200.00   |
| 2350.501    | MV4 Wear Course Mixture (PG 58-34)           | Ton      | 8,200                | \$ 58.00    | \$475,600.00   |
| 2350.502    | LV 3 Nonwear Course Mixture (PG 58-34)       | Ton      | 16,400               | \$ 58.00    | \$951,200.00   |
| 2350.506    | MV4 Bituminous Mixture Production            | Ton      | 100                  | \$ 44.00    | \$4,400.00     |
| 2502.501    | 4" Precast Concrete Headwall                 | Each     | 98                   | \$ 70.00    | \$6,860.00     |
| 2502.521    | 4" TP Pipe Drain                             | Lin Ft   | 1,274                | \$ 3.00     | \$3,822.00     |
| 2502.541    | 4" Perf PE Pipe Drain                        | Lin Ft   | 48,680               | \$ 1.66     | \$80,808.80    |
| 2563.601    | Traffic Control                              | Lump Sum | 1                    | \$ 2,500.00 | \$2,500.00     |
| 2575.604    | Mulch Material Type 2 Special                | Gallon   | 3,245                | \$ 2.00     | \$6,490.00     |
| 2580.501    | Interim Pavement Marking                     | Rd Sta   | 759                  | \$ 4.00     | \$3,036.00     |
| 2582.502    | 4" Solid Line White - Paint                  | Gallon   | 170                  | \$ 7.70     | \$1,309.00     |
| 2582.502    | 4" Solid & Broken Line Yellow - Paint        | Gallon   | 96                   | \$ 7.70     | \$739.20       |
|             |                                              |          |                      | Totals      | \$2,120,586.25 |

# CSAH 2 Cost Summary

- Total Bid Price of \$2,120,586.25 or \$443,000/mile.
- Bid Price of \$1.15/sq yd for Reclaim Bit Surface and \$1.00/sq yd for CIR Bit / Aggr. / Fly Ash a total Reclamation cost of \$143,000 or \$30,000/mile.
- Fly Ash Bid Price of \$60.00/ton for a total cost of \$154,200 or \$32,000/mile
- Bituminous Surface Bid Price of \$58.00/ton for a total cost of \$1,427,000 or \$ 297,000/mile



# CSAH 2 Lessons Learned

- This process is an effective way to rehabilitate Full Depth / Deep Strength designed asphalt pavement.
- Drainage is critical, especially if Pre Grinding is allowed. Use Edge Drains.
- Dust can be an issue if Fly Ash stabilized base is not cover quickly.
- The road grade is raised so shoulders do get narrower.

# CSAH 2 Lessons Learned

- FWD tests were done this summer for strength, results are not in yet.
- Depth of bituminous surfacing could be reduced to save cost if stabilized base is stronger than predicted.
- GPS grade control on the motor patrol would improve the final product.



# CSAH 13 Project

- Project Length 5.54 miles
- Reconstructed in 1989
- Surfaced in 1992 with 3" of Class V aggregate base and 5.5" of P.M. Bituminous
- Spot Overlays by County Forces
- 510 AADT in 2007
- Spring time load posted at 7 tons per axle

# CSAH 13 Existing Condition





# 2007 Pavement Condition Ratings

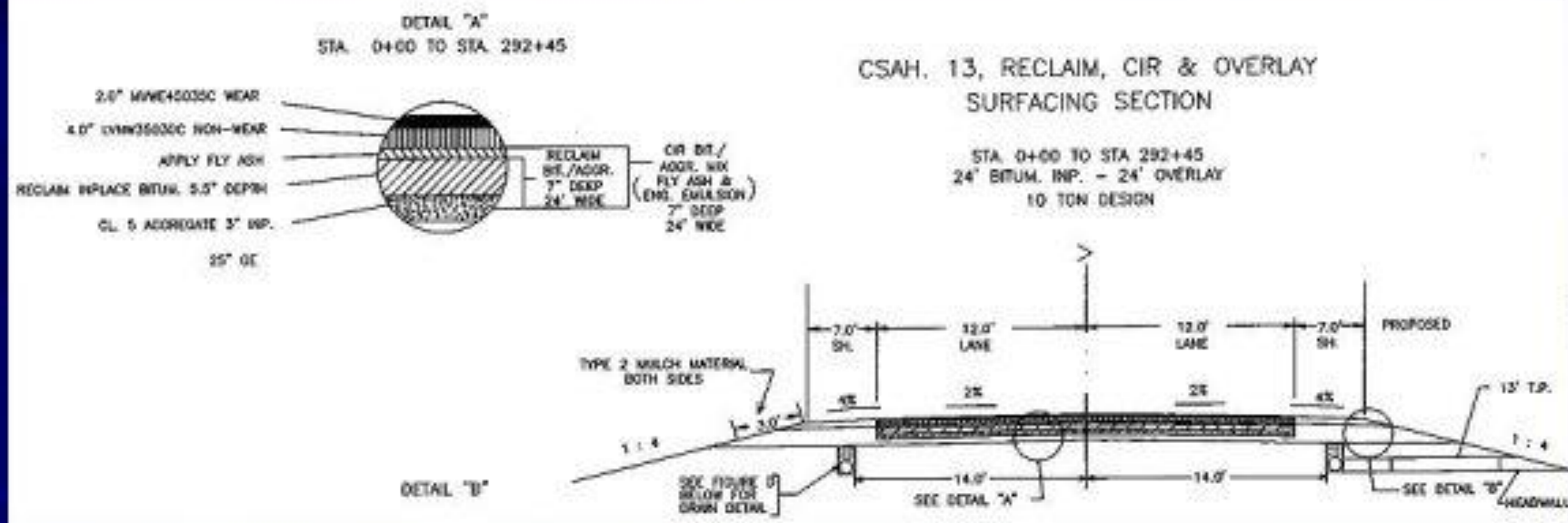
- PSR 2.7 to 2.9
- SR 3.7
- PQI 3.3
- IRI 111 in/mi to 157 in/mi

# CSAH 13 FWD Data Analysis

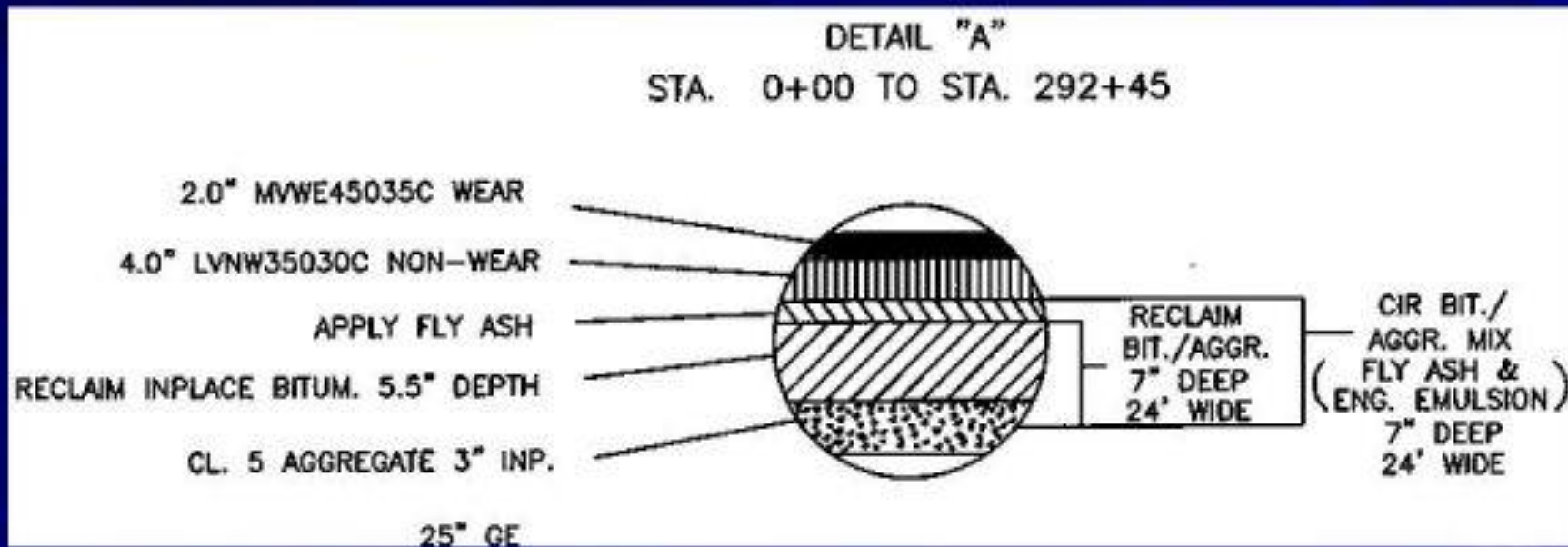
| Summary of Analysis Results |                   |       |       |        |                            |     |          |      |
|-----------------------------|-------------------|-------|-------|--------|----------------------------|-----|----------|------|
|                             | SFB <sub>20</sub> | Eng   | Eff.  | E.G.E. | Axle Load for Design Defl. |     |          | TONN |
|                             |                   |       |       |        | Tons                       |     |          |      |
|                             |                   |       |       |        | AASHTO                     | SF  | Inv. 183 |      |
|                             | mils              | psi   | R-val | inches |                            |     |          | Tons |
| Avg. =                      | 62.2              | 6,398 | 10.0  | 20.9   | 9.2                        | 9.5 | 7.7      | 9.4  |
| Median =                    | 59.9              | 6,091 | 9.3   | 21.3   | 9.1                        | 9.3 | 7.7      | 9.0  |
| Std.Dev. =                  | 18.4              | 7,212 | 4.2   | 4.3    | 1.8                        | 1.8 | 1.3      | 2.7  |
| 85th % =                    | 42.7              | 4,134 | 5.9   | 18.8   | 7.3                        | 7.5 | 6.4      | 6.6  |



# CSAH 13 Typical Section



# CSAH 13 Typical Section Detail





# CSAH 13 Design

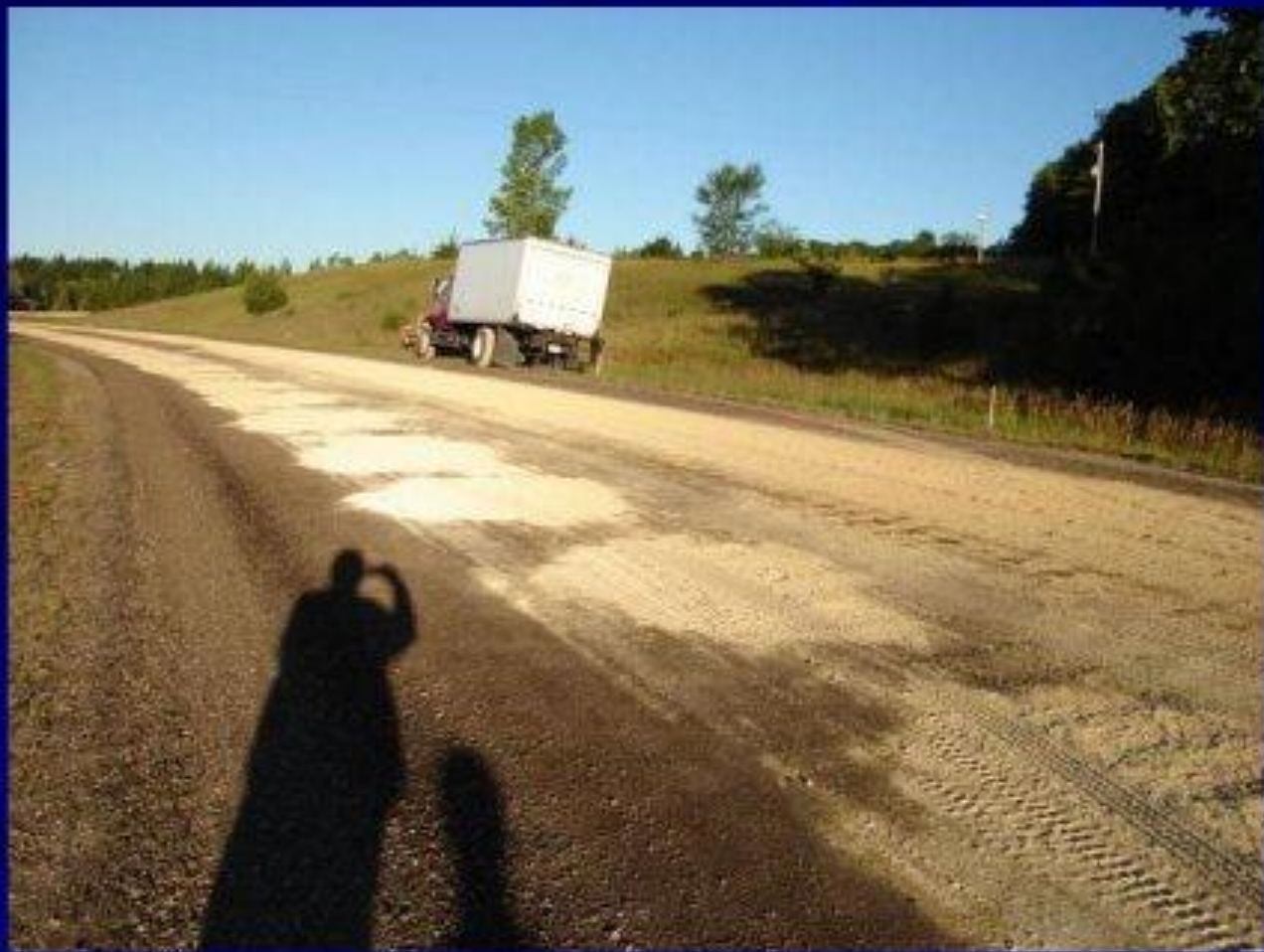
- Edge Drain Tile
- Reclaim existing 5.5" of Bituminous Surface into 3" of Aggregate Base
- Place 2% by weight Fly Ash on top of reclaimed material
- Reclaim Fly Ash and 3% Engineered Emulsion
- Place a 6" Bituminous Surface

# CSAH 13 Pre Grind





# CSAH 13 Fly Ash Applied



# CSAH 13 Reclaim Fly Ash and Emulsion into Base Material





# Stabilized Material







# Initial Compaction with Vibratory Pad Foot Roller



# Rubber tire roller





# Reclaimer with compaction equipment



# Motor Patrol to finish surface





# First lift of pavement on stabilized base



# Bituminous Pavement





| Spec Number | Item                                         | Unit     | Estimated Quantities | Bid Price   | Amount         |
|-------------|----------------------------------------------|----------|----------------------|-------------|----------------|
| 2021.501    | Mobilization                                 | Lump Sum | 1                    | \$25,000.00 | \$25,000.00    |
| 2051.501    | Maint & Restoration of Haul Roads            | Lump Sum | 1                    | \$ 1.00     | \$1.00         |
| 2104.513    | Saw Bituminous Pavement                      | Lin Ft   | 100                  | \$ 3.50     | \$350.00       |
| 2221.501    | Aggregate Shouldering, Class 1               | Ton      | 18,700               | \$ 10.20    | \$190,740.00   |
| 2232.501    | Mill Bituminous Surface                      | Sq. Yd.  | 50                   | \$ 5.00     | \$250.00       |
| 2331.602    | Bit. Mat1 for Cold Mixture (CIR-EE)          | Ton      | 901                  | \$ 500.00   | \$450,500.00   |
| 2331.604    | Reclaim Bituminous Surface & Aggre 12" depth | Sq Yd    | 77,987               | \$ 0.78     | \$60,829.86    |
| 2331.604    | CIR Bit. / Aggr. Mix Fly Ash Mod 12" depth   | Sq Yd    | 77,987               | \$ 0.75     | \$58,490.25    |
| 2331.609    | Fly Ash for Cold Mix, Class C                | Ton      | 553                  | \$ 60.00    | \$33,180.00    |
| 2350.501    | MV4 Wear Course Mixture (PG 58-34)           | Ton      | 9,550                | \$ 58.00    | \$553,900.00   |
| 2350.502    | LV 3 Nonwear Course Mixture (PG 58-34)       | Ton      | 19,100               | \$ 58.00    | \$1,107,800.00 |
| 2350.506    | MV4 Bituminous Mixture Production            | Ton      | 100                  | \$ 44.00    | \$4,400.00     |
| 2502.501    | 4" Precast Concrete Headwall                 | Each     | 117                  | \$ 70.00    | \$8,190.00     |
| 2502.521    | 4" TP Pipe Drain                             | Lin Ft   | 1,521                | \$ 3.00     | \$4,563.00     |
| 2502.541    | 4" Perf PE Pipe Drain                        | Lin Ft   | 58,490               | \$ 1.75     | \$102,357.50   |
| 2563.601    | Traffic Control                              | Lump Sum | 1                    | \$ 2,500.00 | \$2,500.00     |
| 2575.604    | Mulch Material Type 2 Special                | Gallon   | 3,900                | \$ 2.00     | \$7,800.00     |
| 2580.501    | Interim Pavement Marking                     | Rd Sta   | 878                  | \$ 4.00     | \$3,512.00     |
| 2582.502    | 4" Solid Line White - Paint                  | Gallon   | 194                  | \$ 7.70     | \$1,493.80     |
| 2582.502    | 4" Solid & Broken Line Yellow - Paint        | Gallon   | 111                  | \$ 7.70     | \$854.70       |
|             |                                              |          |                      | Totals      | \$2,616,712.11 |



# CSAH 13 Project Costs

- Total Price of \$2,616,712.11 or \$472,000/mile.
- Bid Price of \$0.78/sq yd for Reclaim Bit Surface and \$0.75/sq yd for CIR Bit / Emulsion / Fly Ash for a total Reclamation cost of \$124,000 or \$22,000/mile.
- Fly Ash Bid Price of \$60.00/ton for a total cost of \$33,214 or \$6,000/mile.
- Bituminous Material for Cold Mix (CIR-EE) Bid Price of \$500/ton for a total cost of \$485,000 or \$87,500/mile.
- Bituminous Surface Bid Price of \$58.00/ton for a total cost of \$1,670,000 or \$302,000/mile



# CSAH 13 Lessons Learned

- Compaction of Material after Pre-Grinding.
- Emulsion must break to gain strength.
- The low side of super elevated curves can collect moisture and take longer for emulsion to break.
- Once the excess moisture is out of the Stabilized Base it is very stable and a great paving platform.

# CSAH 24 Existing Conditions

- Project Length of 5.0 miles
- Road was reconstructed in 1992.
- Road was surfaced with 6" of aggregate base and 4" of bituminous in 1995.
- 536 AADT in 2008.
- Springtime load posted at 7 tons per axle.



# CSAH 24 Existing Conditions



# CSAH 24





# CSAH 24 Pavement Failure Area







# CSAH 24 Cracking



# Wheel Path Cracking





# 2007 Pavement Condition Ratings

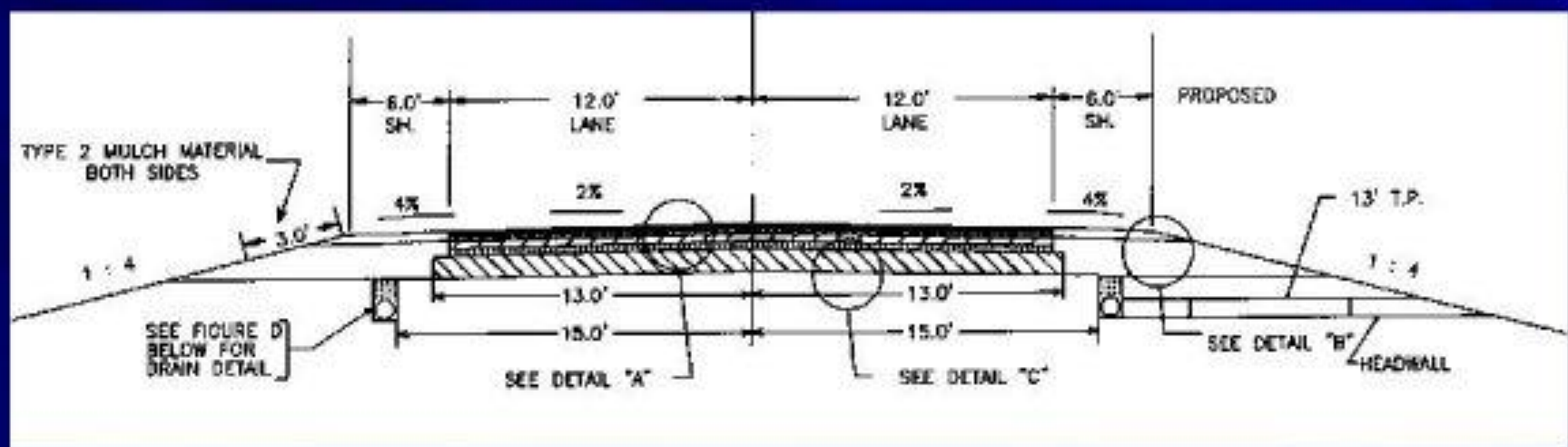
- PSR 3.2
- SR 3.4
- PQI 3.3
- IRI 86 in/mi to 115 in/mi

# CSAH 24 FWD Data Analysis

| Summary of Analysis Results |                  |                 |                 |        |                            |     |       |      |
|-----------------------------|------------------|-----------------|-----------------|--------|----------------------------|-----|-------|------|
|                             | BB <sub>90</sub> | E <sub>eq</sub> | E <sub>FF</sub> | E.G.E. | Axle Load for Design Defl. |     |       | TONN |
|                             |                  |                 |                 |        | Tons                       |     |       |      |
|                             |                  |                 |                 |        | mils                       | psi | R-val |      |
| Avg. =                      | 72.1             | 6,087           | 9.4             | 17.8   | 8.3                        | 8.5 | 6.9   | 8.3  |
| Median =                    | 65.5             | 6,084           | 9.3             | 18.4   | 8.3                        | 8.5 | 6.9   | 8.2  |
| Std.Dev. =                  | 33               | 1,431           | 2.6             | 5.4    | 1.8                        | 1.8 | 1.4   | 2.2  |
| 85% =                       | 51.4             | 4,798           | 7.0             | 12.9   | 6.8                        | 7.0 | 5.7   | 6.4  |

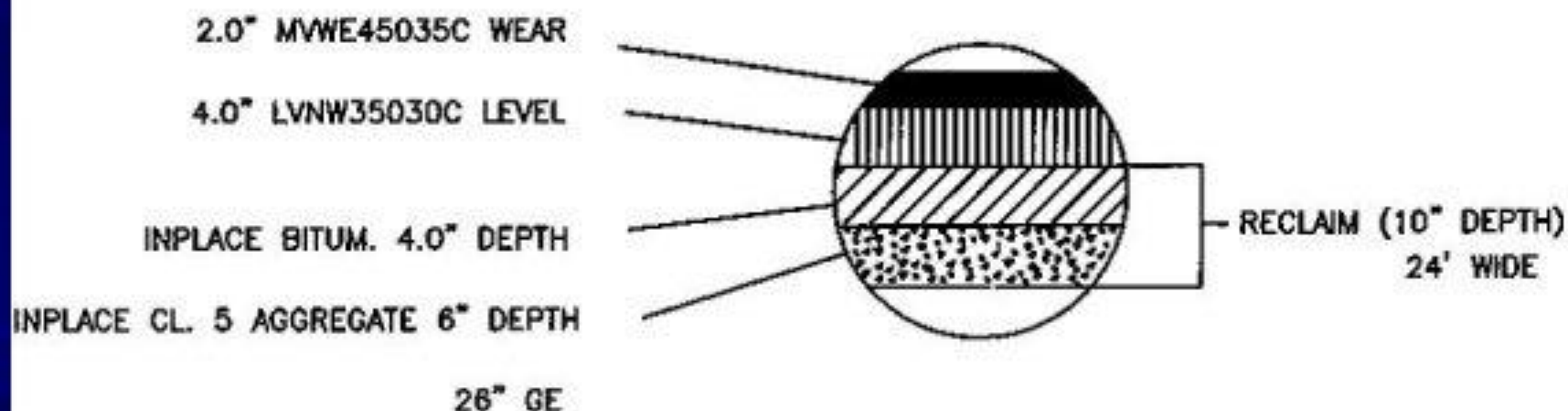


# CSAH 24 Typical Section



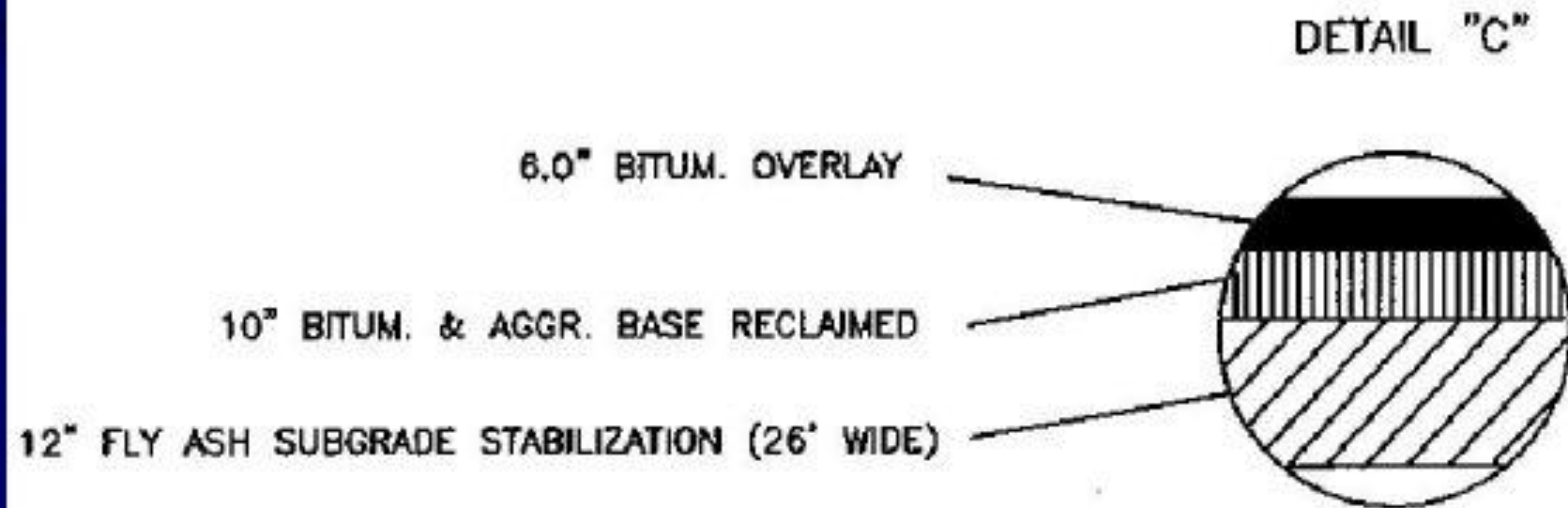
# CSAH 24 Typical Section Detail

DETAIL "A"  
STA. 0+00 TO STA. 266+04





# CSAH 24 Typical Section Detail



# CSAH 24 Design

- Edge Drain tile.
- Reclaim existing bituminous pavement into the aggregate base.
- Salvage the reclaimed material into a stockpile.
- Apply Fly Ash to the sub grade material.
- Reclaim Fly Ash into the sub grade.
- Place salvaged reclaimed material onto stabilized sub grade.



# CSAH 24 Pre Grind



# Reclaimed Surface





# Loading Reclaimed Material with Milling Machine



# Condition of subgrade





# Application of Fly Ash



# Van Spreader





# Fly Ash on the sub grade



# Reclaimer with Water Truck





# Incorporating Fly Ash



# Check Moisture Content





# Initial Compaction



# Compaction





# Shape sub grade



# Water subgrade





# Completed sub grade



# Place Reclaimed Aggregate Base





# Blade and Compact Base Material



# Completed Base





# Final Shaping of the Base with string line



# Shaped, watered and rolled base





# First lift of Bituminous



# CSAH 24 Project Costs

- Total Price of \$2,501,676.54 or \$500,000/mile.
- Reclaim Bituminous and Aggregate Base bid price of \$0.64/sq yd for a cost of \$46,104 or \$9,200/mile.
- Salvage and Place Reclaimed Material bid price of \$4.12 /cu yd each for a cost of \$129,500 or \$26,000/mile.
- Sub Grade Soil Stabilization bid price of \$1.60/sq yd for a cost of \$123,500 or \$24,700/mile.
- Fly Ash Bid Price of \$60.00/ton for a total cost of \$304,500 or \$60,900/mile.
- Bituminous Surface Bid Price of \$58.00/ton for a total cost of \$1,492,000 or \$298,000/mile



# CSAH 24 Lessons Learned

- The process worked.
- Reclaimed material can be difficult to fine grade.

# Here is what we are up against.





# Thank You

Darrell Pettis,  
Le Sueur County Highway Engineer  
Le Center, MN  
507-357-8200  
dpettis@co.le-sueur.mn.us