



# RESEARCH

2008-02

## Evaluation of Paving Fabrics for Isolation of Bituminous Cracking



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## Technical Report Documentation Page

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| 16. Abstract (Limit: 200 words)<br><br>New studies propose to upgrade thousands of County State Aid Highway (CSAH) miles from 7-ton to 9-ton to 10-ton routes. Bituminous pavements require major maintenance for both thermal and distress crack repairs. Structural or maintenance overlays often include intensive and expensive milling or reclaim operations to reduce the effects of existing cracking or crack sealants. Less expensive alternatives to isolate existing problems, retain strength and usability of existing roadways are needed. Paving fabric may: <ol style="list-style-type: none"> <li>1) Isolate overlay pavements from current cracking and moisture intrusion paths,</li> <li>2) Allow retention of base and bituminous for route upgrades, and</li> <li>3) Reduce the need for and impacts of future crack treatments.</li> </ol> <p>This report describes results to date over a three year period of testing spun glass paving fabric as a means of preserving existing bituminous pavements by isolating the effects of heavy crack sealants and reflective cracking. It describes test segments, photo documentation of pre-pave conditions, material used, installation with bituminous overlay projects, monitoring and evaluation, pre-and post-installation surface conditions for the contract report period (2+ years), results of FWD strength comparisons and cost comparisons with mill and replace, and two years' electronic file photo documentation of cracking with/without pavement fabric between new/old bituminous.</p> |  |  |           |
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# Evaluation of Paving Fabrics for Isolation of Bituminous Cracking

## **Final Report**

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## Executive Summary

Existing bituminous pavements require major seasonal maintenance for both thermal and distress crack repairs. Reconstruction, structural upgrades or maintenance overlays generally include intensive and expensive milling or reclaim operations to reduce/retard the effects of existing cracking or crack sealants. Traffic levels and weights on the CSAH system continue to increase; new studies propose to upgrade thousands of CSAH miles from 7-ton to 9-ton to 10-ton routes. Less expensive alternatives to isolate existing problems and retain strength and usability of existing roadways are needed.

Paving fabric may:

- Provide desired isolation of overlay pavements from current cracking, sealants and moisture intrusion,
- Increase retention of base and bituminous for TH, MSAH and CSAH route upgrades, and
- Reduce the need for and impacts of future crack treatments.

Detailed Description of Testing:

- 1) Photo documentation of current conditions
- 2) Specify material and include installation with overlay project(s)
- 3) Document installation procedures and benefits/detriments of procedures
- 4) Evaluate pre-and post-installation surface conditions via video documentation
- 5) Test for strength comparison and cost vs. mill and replace existing bituminous
- 6) Monitor reflective cracking with/without pavement fabric between new/old bituminous

Evaluation Criteria:

- 1) Compatibility with existing pavements and overlay paving procedures
- 2) Isolation of existing cracks/fractures from new overlays at installation
- 3) Reduction or retarding propagation of subsurface cracks and joints into new overlays
- 4) Cost comparison with mill and replacement overlays



**Table ES 1. CSAH #7 Summary Table of Crack-Counts on Test Sections**

| <b>Test Station CSAH#7</b> | <b>Control or Test Section</b> | <b>Left Lane Cracks</b> | <b>Centerline Cracks</b> | <b>Right Lane Cracks</b> |
|----------------------------|--------------------------------|-------------------------|--------------------------|--------------------------|
| 0+25 to 3+ 25              | Test: Fabric Both Lanes        | 4                       |                          | 7                        |
| 3+ 25 to 6+25              | Control: No Fabric             | 5                       |                          | 6                        |
|                            |                                |                         |                          |                          |
| 33+00 to 36+00             | Control: No Fabric             | 4                       |                          | 4                        |
| 36+00 to 39+00             | Test: Fabric Both Lanes        | 4                       |                          | 4                        |
| 39+00 to 42+00             | Control: No Fabric             | 4                       |                          | 4                        |
|                            |                                |                         |                          |                          |
| 42+00 to 45+00             | Control: No Fabric             | 3                       |                          | 4                        |
| 45+00 to 51+00 (600')      | Test: Fabric Both Lanes        | 10                      |                          | 10                       |
| 51+00 to 54+00             | Control: No Fabric             | 3                       |                          | 3                        |
|                            |                                |                         |                          |                          |
| 53+00 to 56+00             | Control: No Fabric             | 3                       |                          | 3                        |
| 56+00 to 59+00             | Test: Centerline Fabric        | 6                       |                          | 5                        |
| 59+00 to 62+00             | Control: No Fabric             | 2                       |                          | 2                        |
|                            |                                |                         |                          |                          |
| 62+00 to 64+00             | Control: No Fabric             | 5                       |                          | 3                        |
| 64+00 to 67+00             | Test: Fabric Both Lanes        | 5                       |                          | 5                        |
| 67+00 to 72+00             | Control: No Fabric             | 6                       |                          | 6                        |

| <b>Test Station CSAH#7</b> | <b>Control or Test Section</b> | <b>Left Lane Cracks</b> | <b>Centerline Cracks</b> | <b>Right Lane Cracks</b> |
|----------------------------|--------------------------------|-------------------------|--------------------------|--------------------------|
| 70+00 to 73+00             | Control: No Fabric             | <b>5</b>                |                          | <b>8</b>                 |
| 73+00 to 76+00             | Test: Fabric Both Lanes        | <b>5</b>                |                          | <b>5</b>                 |
| 76+00 to 79+00             | Control: No Fabric             | <b>3</b>                |                          | <b>3</b>                 |
|                            |                                |                         |                          |                          |
| 101+00 to 104+00           | Control: No Fabric             | <b>6</b>                |                          | <b>6</b>                 |
| 104+00 to 107+00           | Test: Centerline Fabric        | <b>6</b>                |                          | <b>4</b>                 |
| 107+00 to 110+00           | Control: No Fabric             | <b>11</b>               |                          | <b>8</b>                 |
|                            |                                |                         |                          |                          |
| 123+00 to 126+00           | Control: No Fabric             | <b>4</b>                |                          | <b>3</b>                 |
| 126+00 to 129+00           | Test: Fabric Both Lanes        | <b>4</b>                |                          | <b>4</b>                 |
| 129+00 to 132+00           | Control: No Fabric             | <b>7</b>                |                          | <b>7</b>                 |
|                            |                                |                         |                          |                          |
| 210+00 to 213+00           | Control: No Fabric             | <b>7</b>                |                          | <b>8</b>                 |
| 213+00 to 216+00           | Test: Fabric Both Lanes        | <b>7</b>                |                          | <b>7</b>                 |
| 216+00 to 219+00           | Control: No Fabric             | <b>6</b>                |                          | <b>6</b>                 |
|                            |                                |                         |                          |                          |
| 292 to 295+00              | Control: No Fabric             | <b>4</b>                |                          | <b>5</b>                 |
| 295+00 to 298+00           | Test: Centerline Fabric        | <b>3</b>                |                          | <b>3</b>                 |
| 298+00 to 301+00           | Control: No Fabric             | <b>4</b>                |                          | <b>4</b>                 |

**Table ES 2. CSAH #8 Summary Table of Crack-Counts on Test Sections**

| <b>Test Station CSAH #8</b> | <b>Control or Test Section</b> | <b>Left Lane Cracks</b> | <b>Centerline Cracks</b> | <b>Right Lane Cracks</b> |
|-----------------------------|--------------------------------|-------------------------|--------------------------|--------------------------|
| 0+00 to 3+00                | Test: Centerline Fabric        |                         | <b>60 %</b>              |                          |
|                             |                                |                         |                          |                          |
| 0+00 to 105+98              | Test; Centerline Fabric        |                         | <b>60 %</b>              |                          |
|                             |                                |                         |                          |                          |
| 64+00 to 67+00              | Control: No Fabric             | <b>7</b>                |                          | <b>7</b>                 |
| 67+00 to 70+00              | Test: Fabric Both Lanes        | <b>5</b>                |                          | <b>5</b>                 |
| 70+00 to 73+00              | Control: No Fabric             | <b>7</b>                |                          | <b>7</b>                 |
|                             |                                |                         |                          |                          |
| 89+00 to 92+00              | Control: No Fabric             | <b>8</b>                |                          | <b>8</b>                 |
| 92+00 to 95+00              | Test: Fabric Both Lanes        | <b>7</b>                |                          | <b>7</b>                 |
| 95+00 to 98+00              | Control: No Fabric             | <b>4</b>                |                          | <b>4</b>                 |
|                             |                                |                         |                          |                          |

#### **4. Conclusions:**

1. Spun Glass Paving Fabric does not add structural strength when applied between Bituminous Courses (FWD Comparisons)
2. Spun Glass Paving Fabric does not retard early thermal cracking
3. Spun Glass Paving Fabric does not retard early centerline cracking at paver joints
4. Reflective distress cracking did not reappear within the first two years of paving regardless of fabric presence between existing and overlay bituminous
5. Paving fabric can be installed over existing or over fresh blade laid leveling course
6. Paving fabric can isolate heavy crack sealant from new overlay bituminous at less expense than mill and replace removed bituminous
7. Blade Laid Leveling Course mitigates heavy crack sealant effects on main courses
8. Comparable Blade Laid vs. Paving Fabric Costs vs. Mill & Replace at 2005 prices are;
  - A.  $\frac{1}{2}$ " Blade Laid Leveling = \$ .77 / SY (@ \$ 28. / Ton Bit)
  - B. Paving Fabric Costs = \$ 2.50 / SY ( Test Section Prices )
  - C. Mill 2" Depth = \$ .60 / SY Plus Replace 2" Bit = \$ 2.83 /SY for Sum of \$ 3.43 / SY (Bit \$25.75/Ton)

#### **5. Recommendations:**

1. Evaluation of fabric effects should be continued here for results as reflective cracking develops in future years
2. Similar evaluation of paving fabric in less severe winter conditions should be researched
3. Until better data on fabrics is demonstrated, blade laid & overlay would be this researcher's choice for both maintenance and structural overlays

# Chapter 1

## Introduction

Existing bituminous pavements require major seasonal maintenance for both thermal and distress crack repairs, Reconstruction, structural upgrades or maintenance overlays generally include intensive and expensive milling or reclaim operations to reduce / retard the effects of existing cracking or crack sealants. Traffic levels and weights on the CSAH system continue to increase; new studies propose to upgrade thousands of CSAH miles from 7-ton to 9-ton to 10-ton routes. Less expensive alternatives to isolate existing problems and retain strength and usability of existing roadways are needed.

Paving fabric may:

- Provide desired isolation of overlay pavements from current cracking, sealants and moisture intrusion,
- Increase retention of base and bituminous for TH, MSAH and CSAH route upgrades, and
- Reduce the need for and impacts of future crack treatments.

Detailed Description of Testing:

- 7) Photo documentation of current conditions
- 8) Specify material and include installation with overlay project(s)
- 9) Document installation procedures and benefits / detriments of procedures
- 10) Evaluate pre-and post-installation surface conditions via video documentation
- 11) Test for strength comparison and cost vs. mill and replace existing bituminous
- 12) Monitor reflective cracking with / without pavement fabric between new / old bituminous

Evaluation Criteria:

- 1) Compatibility with existing pavements and overlay paving procedures
- 2) Isolation of existing cracks/fractures from new overlays at installation
- 3) Reduction or retarding propagation of subsurface cracks and joints into new overlays
- 4) Cost comparison with mill and replacement overlays

The above information was submitted via the UM/CTS OPERA program to propose developing and evaluating paving fabrics via addition to an upcoming bituminous overlay project. After local staff review of the Red Lake County planned overlay project for 2005, it was decided to put paving fabric installation test sections into the project documents as an additive bid item.

Video photo documentation of the entire roadway was performed in March, 2005 to capture existing conditions as the existing pavement cracks were visible and relatively open in mild winter weather a video camera was mounted on the vehicle, with a digital distance meter mounted in the camera's view to capture both pavement conditions and stationing by distance from the proposed projects' starting point.

After review of the video, test sections were selected with a 300' length of fabric installation in approximately fourteen selected and documented areas. For comparison purposes, the preceding and succeeding 300' adjacent to the test segments would be documented and evaluated as "control" sections with similar soils, base, bituminous, drainage and weather exposure conditions for future comparisons and analyses.

UM/CTS and the researched discussed the proposed test project with members of MN/DOT's research / MN/ROAD staff, including a site visit by MN/DOT technical researchers and analysts. The visitors concurred in the concept, offered to provide technical review and analysis assistance, and Red Lake County advertised, awarded the projects, and funded the paving fabric additives for approximately \$ 70,000. local expense.

Red Lake County funded pre-pave testing by Falling Weight Deflectometer (FWD) via consultant, and also funded post-paving FWD testing by the same consultant of the roadway to ascertain structural strength variations in the fabric vs. non-fabric test segments.

Through the LRRB, the MN/DOT State Aid Engineer was able to obtain support and funding to produce a report of the findings via a Mn/DOT State of Minnesota Path "B" Work Order Contract with Red Lake County to produce a written and electronic file Report as the deliverable, with a completion date of August 31, 2007.

Project documents are available through the SALT website as scanned plans under Red Lake County (# 63) State Aid Projects SAP #'s 63-607-05 and 63-608-09. Included in the paving contract was SAP 63-610-06, which used the same bituminous mix, but was new pavement over newly prepared Base. All projects have similar weather exposure, but the SAP 63-610-06 included saw and seal joints to assist in minimizing low temperature cracking in the new mats.

In early material selection discussions, vendors recommended fabric installation via separate contract, as claims were made that only factory-authorized installers could obtain and install the materials. As the test segments were desired to be evaluated under actual field contract paving conditions, the additive bid item fabric was advertised and awarded as the responsibility of the prime contractor which would be recommended for any production installation of fabric in conjunction with a bituminous overlay project.

The contract was awarded to the low responsive, responsible bidder with the additive fabric item in June for approximately \$ 1.3M including all paving on CSAH 's # 7, 8, and 10 for completion by September, 2005.

Observation and evaluation of the pavement's condition has been sustained with visual inspections of conditions in sub-zero temperatures, and final photo documentation as required to conclude the test project by the specified final deliverable date of August 31, 2007. As recommended later in the Report, a suggestion and description to continue annual analyses of the pavement and fabric's performance has been drafted for consideration by the Mn/DOT researchers and the LRRB.

Following chapters of this Report, its Appendices, and the electronic files for video and electronic slide presentations, are provided for use and distribution by the LRRB and Mn/DOT, and any supported continuation of the test analyses.

## Chapter 2

### Options / Alternatives Tested: Test Segments & Variations

#### 2.1 CSAH # 7: 11 ½” Base & 3” Existing Bit

CSAH #7 is a typical low volume (AADT 660) roadway in Red Lake County, with significant summer heavy truck traffic due to its proximity to major gravel deposits. Its last surfacing of bituminous was placed in 1989, with annual crack sealing operations performed in the summer months. It is a roadway selected for the prospective 10 Ton CSAH network in Northwest Minnesota.

It was scheduled for an overlay in 2005, with the intention of retaining as much structure as possible, renewing the travel surface, enhancing its structural capacity and mitigating the effects of the numerous cracks in the existing bituminous layers. In an effort to test the effects of newly developed paving fabrics for strength enhancement and retarding reflective cracking, various sections were selected for the installation and testing of spun glass paving fabric.

Several options were developed for fabric installation; over existing bituminous with a leveling blade laid layer followed by two lifts of bituminous, and over a blade laid leveling course followed by two lifts of bituminous. Cross section information is contained in Appendix A.



Figure 2.1 CSAH # 7: 11 ½” Base & 3” Existing Bit

## 2.2 CSAH # 8: 2" Base, 8" Layered Bit

CSAH #8 is also a low volume (AADT 770) roadway with significant Summer heavy truck traffic due to its proximity to major gravel deposits and Trunk Highways. Unlike most local CSAH's, it was surfaced over a thinner layer of gravel base, with higher depths of bituminous added for strength. Its last surfacing of bituminous was placed in 1994, with annual crack sealing operations conducted in the Summer months. It is a roadway selected for the prospective 10 Ton CSAH network in Northwest Minnesota.

It was scheduled for an overlay in 2005, with the intention of retaining as much structure as possible, renewing the travel surface, enhancing its structural capacity and mitigating the effects of the numerous cracks in the existing bituminous layers. It displayed a high level of cracking through the centerline paver joints. In an effort to test the effects of newly developed paving fabrics for strength enhancement and retarding reflective cracking, various sections were selected for the installation and testing of spun glass paving fabric, with an emphasis on centerline fabric.

Several options were developed for fabric installation; over existing bituminous with a leveling blade laid layer followed by two lifts of bituminous, and over a blade laid leveling course followed by two lifts of bituminous. Cross section information is contained in Appendix A.



Figure 2.2 CSAH # 8: 2" Base, 8" Layered Bit



### 2.3 Additive Bid Item Fabric Test Segments and Installation Options

Sections of each roadway were selected for installation and testing of the effects of spun glass paving fabric. Due to uncertainty of costs and external interest in fabric testing, the fabric installation was included in the project documents as an additive bid item. The figure below describes the location (by Roadway and Station Number) and type of installation to be tested (over existing, over blade laid, left lane only, right lane only, both lanes, and centerline only) for the test segments selected.

Test sections were specified for lane fabric on a 300' length, with both the preceding and succeeding 300' roadway length identified as a "control" section with similar base, bituminous, drainage, and weather exposure characteristics for comparison purpose.

| ADDITIVE BID ITEM #1<br>SEE SPECIAL PROVISIONS |            |           |          |     |     |     |          |
|--|------------|-----------|----------|-----|-----|-----|----------|
| TEST OPTION                                    | C.S.A.H. # | BEGN STA. | END STA. | LT. | CL. | RT. | SQ. YDS. |
| 1  | #8         | 0+00      | 3+00     |     | X   |     | 100      |
| 2  | #7         | 0+00      | 307+51   |     | X   |     | 9,450    |
| 2  | #8         | 0+00      | 105+98   |     | X   |     | 3,622    |
| 6  | #7         | 0+25      | 3+25     | X   |     | X   | 800      |
| 5  | #7         | 36+00     | 39+00    | X   |     | X   | 800      |
| 6  | #7         | 45+00     | 51+00    | X   |     | X   | 1,600    |
| 4  | #7         | 56+00     | 59+00    |     |     | X   | 400      |
| 6  | #7         | 64+00     | 67+00    | X   |     | X   | 800      |
| 6  | #7         | 73+00     | 76+00    | X   |     | X   | 800      |
| 4  | #7         | 104+00    | 107+00   | X   |     |     | 400      |
| 3  | #7         | 126+00    | 129+00   | X   |     |     | 400      |
| 6  | #7         | 213+00    | 216+00   | X   |     | X   | 800      |
| 6  | #7         | 295+00    | 298+00   | X   |     | X   | 800      |
| 5  | #8         | 67+00     | 70+00    | X   |     | X   | 800      |
| 6  | #8         | 92+00     | 95+00    | X   |     | X   | 800      |
| TOTAL PAVING FABRIC                            |            |           |          |     |     |     | 22,372   |

| ADDITIVE BID ITEM #1<br>SEE SPECIAL PROVISIONS |  |
|--|--|
| TEST OPTIONS - PAVING FABRIC DETAILS           |  |
| (1)  | 3' CENTERLINE STRIP OF FABRIC PLACED LONGITUDINALLY<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR) |
| (2)  | 3' CENTERLINE STRIP OF FABRIC PLACED LONGITUDINALLY<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)     |
| (3)  | FABRIC PLACED ON ONE 12' LANE<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR)                       |
| (4)  | FABRIC PLACED ON ONE 12' LANE<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)                           |
| (5)  | FABRIC PLACED FULL WIDTH 24' WITH 6" OVERLAP<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR)        |
| (6)  | FABRIC PLACED FULL WIDTH 24' WITH 6" OVERLAP<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)            |

Figure 2.3 Bid Item Fabric Test Segments and Installation Options

## Chapter 3 Project and Research Data Collection

### 3.1 CSAH #7: Traditional Base & Bit

For the pre-project analyses, full video of the roadways were captured with station numbering to both document existing conditions and assist in the selection of test segments and control areas. Several types of fabric were considered, with spun glass fiber being the material selected. FWD testing was performed on the existing roadway surfaces for future comparisons with post-pave data to ascertain the strength implications of the heavy spun glass fabric. VHS, digital video and digital still photos were obtained and retained for post-paving analyses. The following figures and graphics are presented here as typical of the data collected. Full electronic video files are contained on the accompanying CD for the Final Report, and may be accessed through the Mn/DOT Research Services and Technical Library functions..

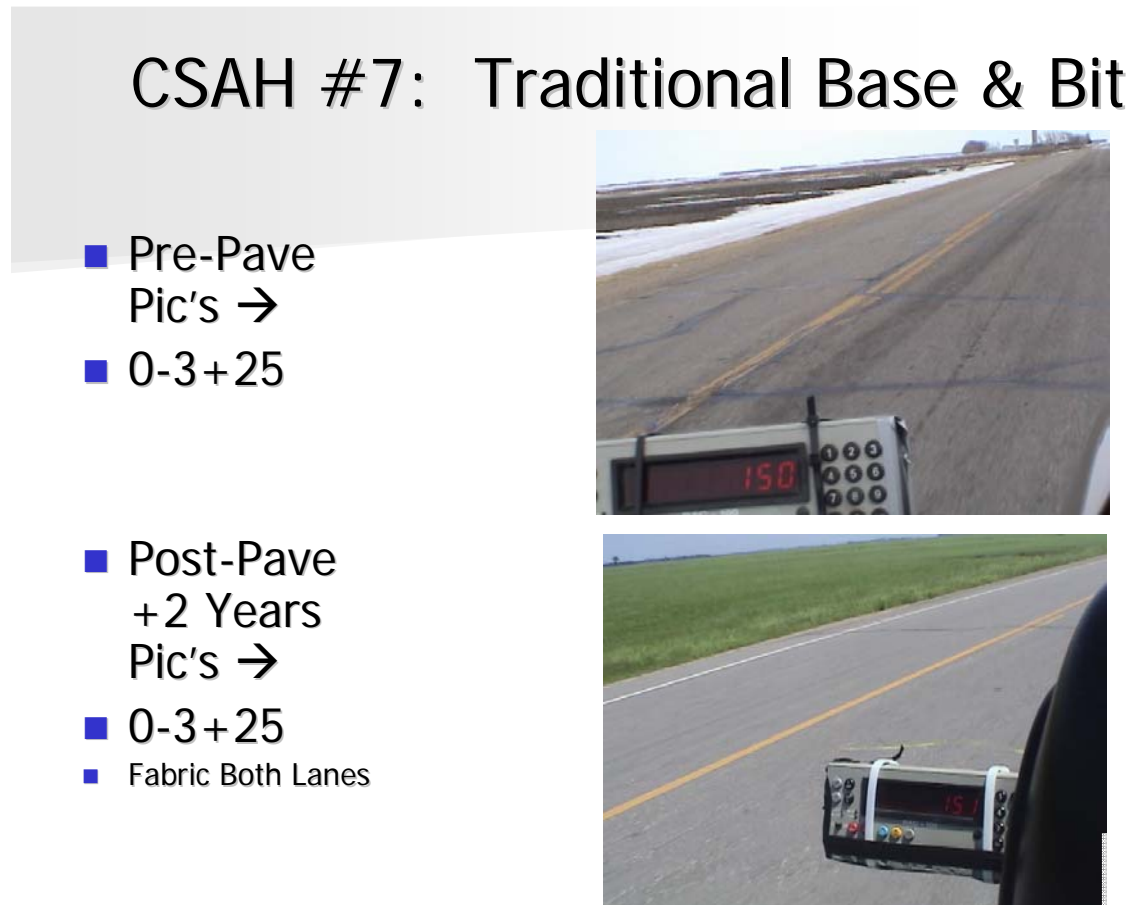


Figure 3.1 CSAH #7 Traditional Base & Bit Fabric Test (0+25) to (3+25)

## CSAH #7: Traditional Base & Bit

- Pre-Pave  
Pic's →
- 213-216



- Post-Pave  
+2 Years  
Pic's →
- 213-216
- Fabric Both Lanes



Figure 3.2 CSAH #7 Traditional Base & Bit Fabric Test (213) to (216)

### 3.2 CSAH #8: Thin Base & Deep Bit

## CSAH #8: Thin Base & Deep Bit

- Pre-Pave  
Pic's →
- 0-300
  
- Post-Pave  
+2 Years  
Pic's →
- 0-300
- 3' Centerline Fabric



Figure 3.3 CSAH #8 Thin Base & Deep Bit Test (0+00) to (3+00)

## CSAH #8: Thin Base & Deep Bit

- Pre-Pave  
Pic's →

- 67-70



- Post-Pave  
+2 Years  
Pic's →

- 67-70

- Fabric Both Lanes



Figure 3.4 CSAH #8 Thin Base & Deep Bit Test (67) to (70)

### 3.3 Project Photos of Construction



Figure 3.5 Fabric Left Lane over ½" Blade Laid Leveling Course



### 3.3.1 Fabric Installation Photos

Fabric installation on the test sections was included in the project documents as an additive bid item. In accordance with manufacturer's published recommendations, installation was to be performed by a manufacturer's authorized installer, in strict accordance with the manufacturer's recommendations. Local installers recommended a separate installation contract, but installation was chosen to be under the responsibility of the primary contractor to ensure installation was properly coordinated with paving operations, and more representative of normal construction contract provisions.

The prime (paving) contractor felt it could have properly installed the fabric without the need for a factory-designated installer, and provided the necessary support and coordination for fabric inclusion in its production operations..

## Fabric for Test Sections



Figure 3.6 Fabric Installation over Existing Bit, Saturation Tack, Spun Glass Rolled Fabric, 2nd Lane Fabric over Existing Bit, Dual Lane Test Segment over Blade Laid

## 3' Centerline Fabric & Paver



Figure 3.7 Centerline Fabric Installation Photos 3' C/L TruPave Fabric over Existing Bit, 3' TruPave Fabric over Blade Laid, 3' Glass Fabric over Existing (Sanded for retention), Wear Course Paving Operations





Figure 3.8 CSAH # 10 Saw & Seal



Figure 3.9 3' Centerline Fabric over Existing Bituminous CSAH #8



Figure 3.10 Project Completion

## Chapter 4

### Summary of Test Section Evaluations, Pave + 2 Years

Upon completion of paving operations, video photo documentation was taken. Pavement condition observations were made during the first winter season, which included only one week of low temperatures in the Fahrenheit minus 20's. Normal crack sealing operations were conducted in the first summer.

Pavement condition observations were made during the second winter, which again included only one week of low temperatures in the Fahrenheit minus 20's. In early summer, observations revealed additional new cracking and extension of previous cracking the previous winter. Prior to summer crack sealing operations, cracks from the second year were painted with yellow chalk for recording and distinguishing second year cracking from the first year's sealed cracks. Video recording was again conducted, with the cracking recorded in each lane and from each of the first two years. The following Figures with tabulations provide the results for each of the Test Sections and the adjacent Control sections. In the electronic Powerpoint file version, actual video of the control and test sections may be observed in motion throughout the control and test sections to more closely observe first year, second year and total cracking through June of 2007.

#### 4.1 CSAH #7: Test Sections

Tabulation of Cracking  
(go to slideshow view and click on video to play)

- **300' w/ Test Fabric**
  - Fabric, 1/2" Blade Laid, NW Bit, WE Bit
  - **300' w/o Fabric**



| Test Station CSAH #7 | Control or Test Section  | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|----------------------|--|--|-------------------|--|
| (0+25) to (3+25)     | <b>Test: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 2 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 3 1 <sup>st</sup> Yr<br>4 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |
| (3+25) to (6+25)     | <b>Control</b>   | 2 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |                   | 6 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 6</b> |

Figure 4.1 CSAH #7 Test Section (0+25) to (3+25)

Tabulation  
of Cracking

(go to slideshow view  
and click on video to play)



| Test Station CSAH #7 | Control or Test Section  | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|----------------------|--|--|-------------------|--|
| 33-36                | <b>Control</b>   | 3 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 4 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |
| 36-39                | <b>Test: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 1 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 4</b> | 2                 | 1 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |
| 39-42                | <b>Control</b>   | 2 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 2 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |

Figure 4.2 CSAH #7 Test Section (36+00) to (39+00)

Tabulation  
of Cracking

(go to slideshow view and click on  
video to play)



| Test Station CSAH #7 | Control or Test Section   | Left Lane Cracks  | Centerline Cracks | Right Lane Cracks   |
|----------------------|---|---|-------------------|---|
| 42-45                | <b>Control</b>  | 3 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 3</b>  |                   | 3 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 4</b>  |
| 45-51                | <b>Test:: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 4 1 <sup>st</sup> Yr<br>6 2 <sup>nd</sup> Yr<br><b>Total = 10</b> |                   | 4 1 <sup>st</sup> Yr<br>6 2 <sup>nd</sup> Yr<br><b>Total = 10</b> |
| 51-54                | <b>Control</b>  | 3 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total =3</b>   |                   | 3 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 3</b>  |

Figure 4.3 CSAH #7 Test Section (45+00) to (51+00)

Tabulation of Cracking

(go to slideshow view and click on video to play)



| Test Station CSAH #7 | Control or Test Section   | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|----------------------|---|--|-------------------|--|
| 53-56                | Control   | 1 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |                   | 1 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |
| 56-59                | <b>Test:: Fabric Right Lane</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 4 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 6</b> |                   | 4 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |
| 59-62                | Control   | 1 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 2</b> |                   | 1 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 2</b> |

Figure 4.4 CSAH #7 Test Section (56+00) to (59+00)

Tabulation of Cracking

(go to slideshow view and click on video to play)



| Test Station CSAH #7 | Control or Test Section  | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|----------------------|--|--|-------------------|--|
| 62-64                | Control  | 2 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 5</b> | 2 Lengthy         | 1 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |
| 64-67                | <b>Test: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 1 1 <sup>st</sup> Yr<br>4 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |                   | 1 1 <sup>st</sup> Yr<br>4 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |
| 67-70                | Control  | 6 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 6</b> |                   | 4 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 6</b> |

Figure 4.5 CSAH #7 Test Section (64+00) to (67+00)

## Tabulation of Cracking

(go to slideshow view and

click on video to play)



| Test Station<br>CSAH #7 | Control or Test Section   | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|-------------------------|---|--|-------------------|--|
| 70-73                   | <b>Control</b>  | 5 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |                   | 4 1 <sup>st</sup> Yr<br>4 2 <sup>nd</sup> Yr<br><b>Total = 8</b> |
| 73-76                   | <b>Test:: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 2 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |                   | 3 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |
| 76-79                   | <b>Control</b>  | 3 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |                   | 3 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |

Figure 4.6 CSAH #7 Test Section 73-76

## Tabulation of Cracking

(go to slideshow view and click on

video to play)



| Test Station<br>CSAH #7 | Control or Test Section  | Left Lane Cracks  | Centerline Cracks | Right Lane Cracks  |
|-------------------------|--|---|-------------------|--|
| 101-104                 | <b>Control</b>   | 4 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 6</b>  |                   | 2 1 <sup>st</sup> Yr<br>4 2 <sup>nd</sup> Yr<br><b>Total = 6</b> |
| 104-107                 | <b>Test:: Fabric Left Lane</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 2 1 <sup>st</sup> Yr<br>4 2 <sup>nd</sup> Yr<br><b>Total = 6</b>  |                   | 2 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |
| 107-110                 | <b>Control</b>   | 8 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 11</b> |                   | 5 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 8</b> |

Figure 4.7 CSAH #7 Test Section 104-107



**Tabulation of Cracking**

(go to slideshow view and click on

video to play)



| Test Station CSAH #7 | Control or Test Section  | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|----------------------|--|--|-------------------|--|
| 123-126              | Control  | 3 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 3 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |
| 126-129              | Test: Fabric Left Lane<br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 3 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 2 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |
| 129-132              | Control  | 5 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |                   | 6 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |

Figure 4.8 CSAH #7 Test Section 126-129

**Tabulation of Cracking**

(go to slideshow view and click on

video to play)



| Test Station CSAH #7 | Control or Test Section   | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|----------------------|---|--|-------------------|--|
| 210-213              | Control   | 7 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 7</b> | 1                 | 6 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 8</b> |
| 213-216              | Test: Fabric Both Lanes<br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 4 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 7</b> | 4                 | 4 1 <sup>st</sup> Yr<br>3 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |
| 216-219              | Control   | 4 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 6</b> | 2                 | 4 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 6</b> |

Figure 4.9 CSAH #7 Test Section 213-216

Tabulation  
of Cracking  
(go to slideshow  
view and click on

video to play)



| Test Station<br>CSAH #7 | Control or Test Section  | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|-------------------------|--|--|-------------------|--|
| <b>292-295</b>          | <b>Control</b>   | 2 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 5 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |
| <b>295-298</b>          | <b>Test: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 2 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |                   | 2 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 3</b> |
| <b>298-301</b>          | <b>Control</b>   | 3 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 3 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |

Figure 4.10 CSAH #7 Test Section 295-298



## 4.2 CSAH #8 Test Sections

Tabulation  
of Cracking  
(go to slideshow  
view and click on

video to play)



| Test Station<br>CSAH #8 | Control or Test Section   | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|-------------------------|---|--|-------------------|--|
| <b>0-3+00</b>           | <b>Test: 3' Centerline Fabric</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total = ???</b> |                   | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total =</b> |
| <b>3-6</b>              | <b>Control</b>  | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total =</b>     |                   | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total =</b> |

Figure 4.11 CSAH #8 Test Section 0-3+00X

Tabulation  
of Cracking



| Test Station<br>CSAH #8 | Control or Test Section  | Left Lane Cracks   | Centerline<br>Cracks | Right Lane Cracks  |
|-------------------------|--|--|----------------------|--|
| <b>64-67</b>            | <b>Control</b>   | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |                      | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |
| <b>67-70</b>            | <b>Test: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |                      | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |
| <b>70-73</b>            | <b>Control</b>   | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |                      | X 1 <sup>st</sup> Yr<br>Y 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |

Figure 4.12 CSAH #8 Test Section 67-70

Tabulation  
of Cracking  
(go to slideshow  
view and click on

video to play)



| Test Station<br>CSAH #8 | Control or Test Section  | Left Lane Cracks   | Centerline Cracks | Right Lane Cracks  |
|-------------------------|--|--|-------------------|--|
| 89-92                   | <b>Control</b>   | 6 1 <sup>st</sup> Yr<br>2 2 <sup>nd</sup> Yr<br><b>Total = 8</b> | 3                 | 4 1 <sup>st</sup> Yr<br>4 2 <sup>nd</sup> Yr<br><b>Total = 8</b> |
| 92-95                   | <b>Test: Fabric Both Lanes</b><br>Black= 1 <sup>st</sup> year sealed cracks<br>Yellow = 2 <sup>nd</sup> year unsealed cracks | 6 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 7</b> | 3                 | 6 1 <sup>st</sup> Yr<br>1 2 <sup>nd</sup> Yr<br><b>Total = 7</b> |
| 95-98                   | <b>Control</b>   | 4 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 4</b> |                   | 5 1 <sup>st</sup> Yr<br>0 2 <sup>nd</sup> Yr<br><b>Total = 5</b> |

Figure 4.13 CSAH #8 Test Section 92-95

**Chapter 5**  
**Data Summary @ Pave + 2 Years**

Table 5.1 CSAH #7 Data Summary @ Pave + 2 Years

| <b>Test Station CSAH #7</b>                    | <b>Control or Test Section</b> | <b>Left Lane Cracks</b> | <b>Centerline Cracks</b> | <b>Right Lane Cracks</b> |
|--|--------------------------------|-------------------------|--------------------------|--------------------------|
| <b>0+25 to 3+ 25</b>                           | <b>Test: Centerline Fabric</b> | <b>4</b>                |                          | <b>7</b>                 |
| 3+ 25 to 6+25                                  | Control: No Fabric             | <b>5</b>                |                          | <b>6</b>                 |
|  |                                |                         |                          |                          |
| 33+00 to 36+00                                 | Control                        | <b>4</b>                |                          | <b>4</b>                 |
| <b>36+00 to 39+00</b>                          | <b>Test: Fabric Both Lanes</b> | <b>4</b>                |                          | <b>4</b>                 |
| 39+00 to 42+00                                 | Control                        | <b>4</b>                |                          | <b>4</b>                 |
|  |                                |                         |                          |                          |
| 42+00 to 45+00                                 | Control                        | <b>3</b>                |                          | <b>4</b>                 |
| <b>45+00 to 51+00<br/>(Note Length = 600')</b> | <b>Test: Fabric Both Lanes</b> | <b>10</b>               |                          | <b>10</b>                |
| 51+00 to 54+00                                 | Control                        | <b>3</b>                |                          | <b>3</b>                 |
|  |                                |                         |                          |                          |

| <b>Test Station CSAH #7</b> | <b>Control or Test Section</b> | <b>Left Lane Cracks</b> | <b>Centerline Cracks</b> | <b>Right Lane Cracks</b> |
|-----------------------------|--------------------------------|-------------------------|--------------------------|--------------------------|
| 53+00 to 56+00              | Control: No Fabric             | <b>3</b>                |                          | <b>3</b>                 |
| <b>56+00 to 59+00</b>       | <b>Test: Centerline Fabric</b> | <b>6</b>                |                          | <b>5</b>                 |
| 59+00 to 62+00              | Control: No Fabric             | <b>2</b>                |                          | <b>2</b>                 |
|                             |                                |                         |                          |                          |
| 62+00 to 64+00              | Control                        | <b>5</b>                |                          | <b>3</b>                 |
| <b>64+00 to 67+00</b>       | <b>Test: Fabric Both Lanes</b> | <b>5</b>                |                          | <b>5</b>                 |
| 67+00 to 72+00              | Control                        | <b>6</b>                |                          | <b>6</b>                 |
|                             |                                |                         |                          |                          |
| 70+00 to 73+00              | Control                        | <b>5</b>                |                          | <b>8</b>                 |
| <b>73+00 to 76+00</b>       | <b>Test: Fabric Both Lanes</b> | <b>5</b>                |                          | <b>5</b>                 |
| 76+00 to 79+00              | Control                        | <b>3</b>                |                          | <b>3</b>                 |
| 101+00 to 104+00            | Control: No Fabric             | <b>6</b>                |                          | <b>6</b>                 |
| <b>104+00 to 107+00</b>     | <b>Test: Centerline Fabric</b> | <b>6</b>                |                          | <b>4</b>                 |
| 107+00 to 110+00            | Control: No Fabric             | <b>11</b>               |                          | <b>8</b>                 |
|                             |                                |                         |                          |                          |

| <b>Test Station CSAH #7</b> | <b>Control or Test Section</b> | <b>Left Lane Cracks</b> | <b>Centerline Cracks</b> | <b>Right Lane Cracks</b> |
|-----------------------------|--------------------------------|-------------------------|--------------------------|--------------------------|
| 123+00 to 126+00            | Control                        | <b>4</b>                |                          | <b>3</b>                 |
| <b>126+00 to 129+00</b>     | <b>Test: Fabric Both Lanes</b> | <b>4</b>                |                          | <b>4</b>                 |
| 129+00 to 132+00            | Control                        | <b>7</b>                |                          | <b>7</b>                 |
|                             |                                |                         |                          |                          |
| 210+00 to 213+00            | Control                        | <b>7</b>                |                          | <b>8</b>                 |
| <b>213+00 to 216+00</b>     | <b>Test: Fabric Both Lanes</b> | <b>7</b>                |                          | <b>7</b>                 |
| 216+00 to 219+00            | Control                        | <b>6</b>                |                          | <b>6</b>                 |
|                             |                                |                         |                          |                          |
| 292 to 295+00               | Control: No Fabric             | <b>4</b>                |                          | <b>5</b>                 |
| <b>295+00 to 298+00</b>     | <b>Test: Centerline Fabric</b> | <b>3</b>                |                          | <b>3</b>                 |
| 298+00 to 3-1+00            | Control: No Fabric             | <b>4</b>                |                          | <b>4</b>                 |
|                             |                                |                         |                          |                          |

Table 5.2 CSAH #8 Data Summary @ Pave + 2 Years

| <b>Test Station<br/>CSAH #8</b> | <b>Control or<br/>Test Section</b>     | <b>Left Lane<br/>Cracks</b> | <b>Centerline<br/>Cracks</b> | <b>Right<br/>Lane<br/>Cracks</b> |
|---------------------------------|--|-----------------------------|------------------------------|----------------------------------|
| 64+00 to 67+00                  |  | <b>7</b>                    |                              | <b>7</b>                         |
| <b>67+00 to 70+00</b>           | <b>Test:<br/>Centerline<br/>Fabric</b> | <b>5</b>                    | <b>60%</b>                   | <b>5</b>                         |
| 70+00 to 73+00                  | Control: No<br>Fabric                  | <b>7</b>                    |                              | <b>7</b>                         |
|                                 |  |                             |                              |                                  |
| 89+00 to 92+00                  | Control                                | <b>8</b>                    |                              | <b>8</b>                         |
| <b>92+00 to 95+00</b>           | <b>Test: Fabric<br/>Both Lanes</b>     | <b>7</b>                    |                              | <b>7</b>                         |
| 95+00 to 98+00                  | Control                                | <b>4</b>                    |                              | <b>4</b>                         |
|                                 |  |                             |                              |                                  |
|                                 | <b>Control</b>                         |                             |                              |                                  |
| <b>0- 105+98</b>                | <b>Test:: Centerline<br/>Fabric</b>    |                             | <b>60 %</b>                  |                                  |
|                                 | <b>Control</b>                         |                             |                              |                                  |

### 5.1 Falling Weight Deflectometer Analyses

FWD tests were conducted on both roadways, on both Test and adjacent Control sections. There were no apparent differences in the structural capacities between fabric and non-fabric segments. Extracts from the Report and FWD Data are included in Appendix B.

## 5.2 Other Related Information

The same bituminous mix (PG 58-34 Binder, no RAP) was utilized on CSAH #10 (SAP 63-610-06) as new bituminous over new base, with saw and seal joints installed. To date, after two winters of subzero temperatures, thermal cracking is nearly non-existent, while thermal cracking is appearing at nominal 50' intervals in the CSAH # 7 and CSAH #8 overlay areas regardless of fabric placement. All have similar weather conditions and exposure.

### 2005 CSAH # 10 New Bit on New Base

- New 16" Base
  - Drain Tile & Geotex Type 5 Fabric in selected areas
  - Same Bit as CSAH #7 & #8
    - PG 58-28
    - No RAP
  - Saw & Seal
  - No Paving Fabric
  - Same weather exposure
  - Same age ( 2 years)
- Go to slideshow & click pic



## Chapter 6

### Conclusions

1. Spun Glass Paving Fabric does not add structural strength when applied between Bituminous Courses (FWD Comparisons).
2. Spun Glass Paving Fabric does not retard early thermal cracking.
3. Spun Glass Paving Fabric does not retard early centerline cracking at paver joints.
4. Reflective distress cracking did not reappear within the first two years of paving regardless of fabric presence between existing and overlay bituminous.
5. Paving fabric can be installed over existing or over fresh blade laid leveling course.
6. Paving fabric can isolate heavy crack sealant from new overlay bituminous at less expense than mill and replace removed bituminous.
7. Blade Laid Leveling Course mitigates heavy crack sealant effects on main courses.
8. Comparable Blade Laid vs. Paving Fabric Costs vs. Mill & Replace are;
  - a.  $\frac{1}{2}$ " Blade Laid Leveling = \$ .77 / SY (@ \$ 28. / Ton Bit)
  - b. Paving Fabric Costs = \$ 2.50 / SY ( Test Section Prices )
  - c. Mill 2" Depth = \$ .60 / SY Plus Replace 2" Bit = \$ 2.83 /SY for Sum of \$ 3.43 / SY (Bit \$25.75/Ton)



## **Chapter 7**

### **Recommendations**

1. Evaluation of fabric effects should be continued here for results as reflective cracking develops in future years
2. Similar evaluation of paving fabric in less severe winter conditions should be researched
3. Until better data on fabrics is demonstrated, blade laid & overlay would be this researcher's choice for both maintenance and structural overlays

## **References**

Minnesota Department of Transportation Standard Specifications for Highway Construction (2001 edition).

Minnesota Department of Transportation Specification 2350 / 2360 (2005 Edition) for Bituminous Concrete Mixtures (available via Mn/DOT website).

State Aid Projects 63-607-05 and 63-608-09 (Electronic Plans available via Mn/DOT State Aid for Local Transportation website).

**Appendix A**  
**Project Location and Description**

# A.1 Project Location

## RED LAKE COUNTY

### CONSTRUCTION PLAN FOR BITUMINOUS OVERLAY AND AGGREGATE SHOULDERING.

C.S.A.H. # 7, BETWEEN U.S. #59 (2.0 MILES SOUTH OF BROOKS) AND C.S.A.H. #8 (5.0 MILES S.W. OF OKLEE)  
 LOCATED ON C.S.A.H. # 5, BETWEEN THE SOUTH COUNTY LINE (6.0 MILES S.W. OF OKLEE) AND T.H. # 92 (4.0 MILES SOUTH OF OKLEE) (GEOGRAPHIC DESCRIPTION)  
 FROM (C.S.A.H. #7) A POINT ON THE SEC. LINE, 360.0' WEST OF THE NORTH 1/4 COR. SEC. 35, T. 150 N., R. 41 W. TO A POINT ON THE SEC. LINE 957.85' EAST OF THE S.E. COR., SEC. 27, T. 150 N., R. 41 W.  
 TO (C.S.A.H. #8) FROM THE S.W. COR. OF SEC. 35, T. 150 N., R. 41 W. TO A POINT 465.53' N.E. OF THE S.W. COR. OF SEC. 25, T. 150 N., R. 41 W. (LEGAL DESCRIPTION)

S.A.P. PROJ. NO. 63-607-05

S.A.P. PROJ. NO. 63-608-09

|                   |           |      |      |       |
|-------------------|-----------|------|------|-------|
| GROSS LENGTH      | 30,751.55 | FEET | 5.82 | MILES |
| BRIDGES-LENGTH    | 0         | FEET | 0    | MILES |
| EXCEPTIONS-LENGTH | 0         | FEET | 0    | MILES |
| NET LENGTH        | 30,751.55 | FEET | 5.82 | MILES |

|                   |           |      |      |       |
|-------------------|-----------|------|------|-------|
| GROSS LENGTH      | 10,598.47 | FEET | 2.01 | MILES |
| BRIDGES-LENGTH    | 0         | FEET | 0    | MILES |
| EXCEPTIONS-LENGTH | 0         | FEET | 0    | MILES |
| NET LENGTH        | 10,598.47 | FEET | 2.01 | MILES |

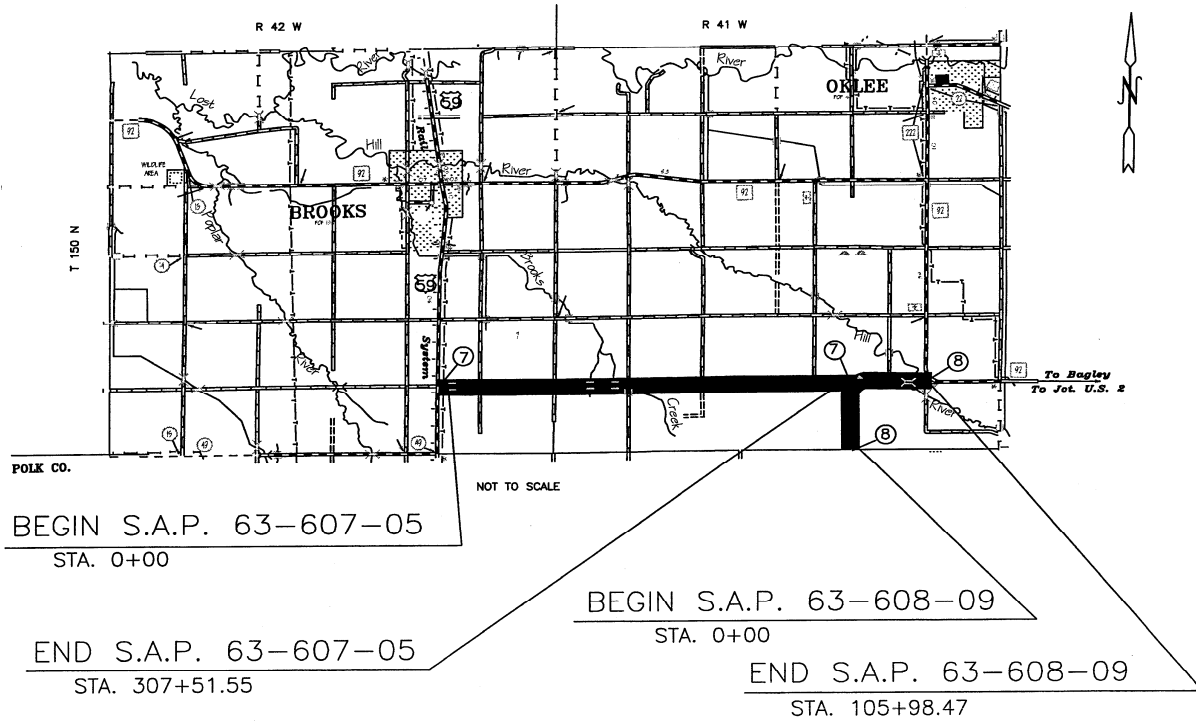


Figure A.1 Project Location

### A.2.1 CSAH # 7: 11 1/2" Base & 3" Existing Bituminous

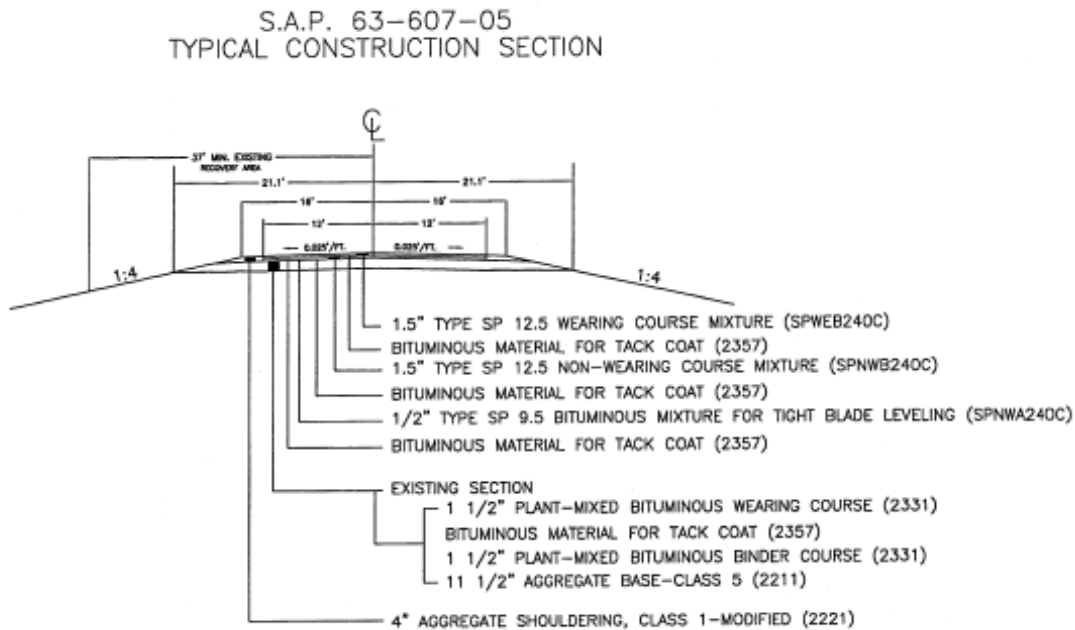


Figure A.2 CSAH #7 Cross Section

### CSAH #8 2" Base, 8" Layered Bituminous

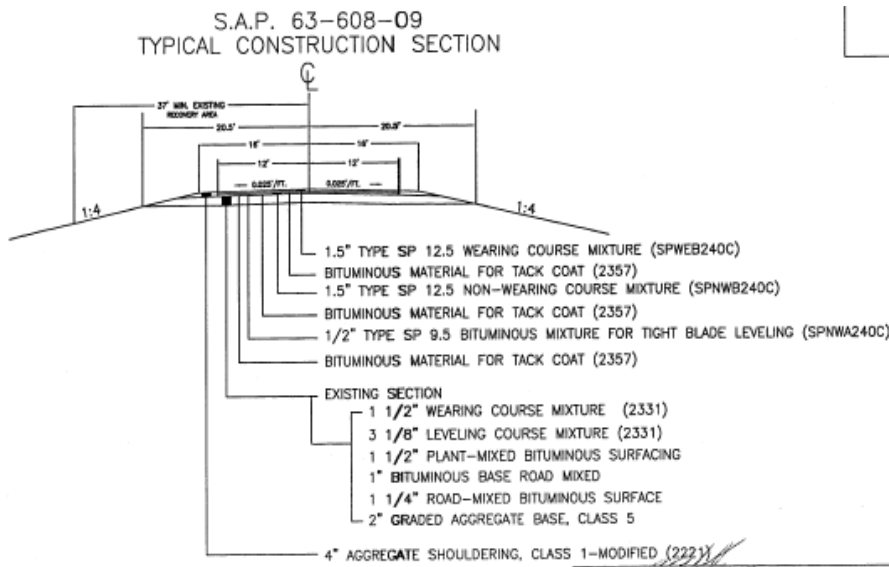


Figure A.3 CSAH #8 Cross Section

### A.3 Test Sections and Fabric Placement

| ADDITIVE BID ITEM #1<br>SEE SPECIAL PROVISIONS |            |           |          |     |    |     |          |
|--|------------|-----------|----------|-----|----|-----|----------|
| TEST OPTION                                    | C.S.A.H. # | BEGN STA. | END STA. | LT. | CL | RT. | SQ. YDS. |
| 1  | #8         | 0+00      | 3+00     |     | X  |     | 100      |
| 2  | #7         | 0+00      | 307+51   |     | X  |     | 9,450    |
| 2  | #8         | 0+00      | 105+98   |     | X  |     | 3,522    |
| 6  | #7         | 0+25      | 3+25     | X   |    | X   | 800      |
| 5  | #7         | 36+00     | 39+00    | X   |    | X   | 800      |
| 6  | #7         | 45+00     | 51+00    | X   |    | X   | 1,600    |
| 4  | #7         | 58+00     | 59+00    |     |    | X   | 400      |
| 6  | #7         | 64+00     | 67+00    | X   |    | X   | 800      |
| 6  | #7         | 73+00     | 76+00    | X   |    | X   | 800      |
| 4  | #7         | 104+00    | 107+00   | X   |    |     | 400      |
| 3  | #7         | 128+00    | 129+00   | X   |    |     | 400      |
| 6  | #7         | 213+00    | 216+00   | X   |    | X   | 800      |
| 6  | #7         | 295+00    | 298+00   | X   |    | X   | 800      |
| 5  | #8         | 67+00     | 70+00    | X   |    | X   | 800      |
| 6  | #8         | 92+00     | 95+00    | X   |    | X   | 800      |
| TOTAL PAVING FABRIC                            |            |           |          |     |    |     | 22,372   |

| ADDITIVE BID ITEM #1<br>SEE SPECIAL PROVISIONS |  |
|--|--|
| TEST OPTIONS - PAVING FABRIC DETAILS           |  |
| (1)  | 3" CENTERLINE STRIP OF FABRIC PLACED LONGITUDINALLY<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR) |
| (2)  | 3" CENTERLINE STRIP OF FABRIC PLACED LONGITUDINALLY<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)     |
| (3)  | FABRIC PLACED ON ONE 12' LANE<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR)                       |
| (4)  | FABRIC PLACED ON ONE 12' LANE<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)                           |
| (5)  | FABRIC PLACED FULL WIDTH 24' WITH 6" OVERLAP<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR)        |
| (6)  | FABRIC PLACED FULL WIDTH 24' WITH 6" OVERLAP<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)            |

Figure A.4 Test Sections and Fabric Placement

## **Appendix B**

### **Paving Fabric Data/Source**

(The authors and the Minnesota Department of Transportation and/or Center for Transportation Studies do not endorse products of manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to this report.)

# TRUPAVE® DELIVERS ADDED PROTECTION FOR ANY PAVEMENT.

TruPave® engineered paving mat from Owens Corning Trumbull is a pavement interlayer designed to create a moisture-resistant barrier, retard reflective cracking and stand up to high-temperature hot-mix designs. And at the end of the pavement's life, it's millable and recyclable. The result of these benefits? TruPave engineered paving mat can extend the performance of your pavement rehabilitation investment by up to 500 percent.

Highway, parking lot, runway or driveway—TruPave engineered paving mat is designed to preserve and extend the life of any hot-mix asphalt concrete surface. It can also help reduce long-term maintenance and rehabilitation costs.



### PERFECT FOR MAINTENANCE JOBS.

TruPave engineered paving mat is designed for use with a wide range of existing pavement conditions and maintenance objectives. Refer to the following chart for a summary of applications and uses, as based upon the existing pavement conditions.

|                                |                     | WHEN TO USE TRUPAVE® ENGINEERED PAVING MAT |              |                     |                     |                     | REPAIRS<br>(CRACKS, PATCHES, POTHOLES) |
|--------------------------------|---------------------|--|--------------|---------------------|---------------------|---------------------|--|
|                                |                     | SPOT TACKLING                              | ROAD REPAIRS | ROAD RECONSTRUCTION | ROAD RECONSTRUCTION | ROAD RECONSTRUCTION |  |
| RECONSTRUCTION APPLICATIONS    | SPOT TACKLING       |  | ●            | ●                   | ●                   |                     |  |
|                                | ROAD REPAIRS        | ●  | ●            | ●                   | ●                   |                     |  |
|                                | ROAD RECONSTRUCTION | ●  | ●            | ●                   | ●                   |                     |  |
|                                | ROAD RECONSTRUCTION | ●  | ●            | ●                   | ●                   |                     |  |
|                                | ROAD RECONSTRUCTION | ●  | ●            | ●                   | ●                   |                     |  |
| EXISTING PAVEMENT APPLICATIONS | ROAD REPAIRS        |  | ●            | ●                   | ●                   |                     |  |
|                                | ROAD RECONSTRUCTION |  | ●            | ●                   | ●                   |                     |  |
|                                | ROAD RECONSTRUCTION |  | ●            | ●                   | ●                   |                     |  |

Always consult our website and product quality management strategies. Contact a TruPave regional representative with a professional engineer and your local authority. TruPave engineered paving mat data prior to buying your product.

For more information about the full range of TruPave engineered paving products, please contact your authorized Owens Corning Trumbull Dealer or visit us online at [www.owenscorning.com/trumpave](http://www.owenscorning.com/trumpave).



TRUPAVE® ENGINEERED PAVING MAT  
TRUE PERFORMANCE. TRUE PROTECTION.

Figure B.1 Owens Corning Trumbull TruPave Paving Fabric Data



Bituminous : Mn/DOT Spec 2350 / 2360 Gyratory Mix Design

In 2005 test sections on Red Lake CSAH's 7 and 8 (SAP's 63-607-05 and 63-608-09) were paved with 1.5-in. of wear and 1.5-in. of non-wear hot mix asphalt (HMA) placed above 0.5-in. of blade leveled HMA material.

The HMA was designed for traffic level 2 (40 design gyrations) and used PG 58-34 asphalt binder. Wear and non-wear courses were constructed from aggregates having 12.5-mm nominal maximum aggregate size (NMAS). The leveling course was constructed from aggregates having 9.5-mm NMAS.

# FWD Test Report Results and Data

## A Pavement Evaluation Report

Deflection Testing and Analysis  
CSAH 5, 7, 8, 10, 11, 13  
Red Lake County, Minnesota

*Prepared for*

**Red Lake County Highway Department**

### Professional Certification

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.



Chunhua Han, PhD PE  
Associate Principal  
License Number: 22493  
December 14, 2005

Project BL-05-05134

Braun Intertec Corporation

Effective GE is high for all of CSAH 5, ranging from 19.5 inches (96+00 to 86+00) to 28.0 inches (420+04 to 312+00). GE varies accordingly with changes in asphalt and aggregate base thickness, suggesting these layers are typically intact. Based on the anticipated traffic, the GE for most of the sections is adequate for 9-ton design. The exception is the short section from 96+00 to 86+00, which has substantially less asphalt than its adjoining sections (3 total inches). The asphalt layer is also particularly distressed compared to the rest of the section and thus likely weakened. Based on the table *Flexible Pavement Design Using Soil Factors* in the Minnesota Department of Transportation *State Aid Manual*, required GE for a 9-ton road with a Soil Factor of 130 and traffic consisting of less than 150 heavy commercial vehicles per day is 22.0. Despite the sufficient calculated load capacity, this section should be considered for repair in the near future to prevent severe failure from occurring.

Effective GE for CSAH 7 and 8 was not derived using Mn/DOT methods, but was converted from the Effective Structure Number (EffSN) determined by AASHTO methods as discussed in C.1.d. Seasonal Correction Factors required to adjust the deflection for spring season were found to be inadequate in correcting the data from the late June deflection testing, although AASHTO and Mn/DOT methods agree closely for the testing performed for this report (within 1 inch of equivalent aggregate base). To remain consistent, we converted the EffSN values discussed in C.1.d to GE using default factors.

Table 1 is a complete summary of analysis results for every tested section, arranged by test option.

**Table 1 - FWD Analysis Results**

| Test Option | Section | Termini                                  | Total AC (in.) | Daily ESAL | FWD Analysis Results |                   |          |        |
|-------------|---------|--|----------------|------------|----------------------|-------------------|----------|--------|
|             |         |  |                |            | EffR85               | EGE85             | 9-Ton OL | TONN85 |
| 1           | CSAH 10 | Polk Co Line (0+00) to CSAH 1 (212+22)   | 4.0            | 5          | --                   | --                | --       | 10.0   |
| 1           | CSAH 10 | CSAH 1 to N Co Line                      | 7.0            | 5          | --                   | --                | --       | 10.0   |
| 2           | CSAH 7  | 0+00 (TH 59) to 307+51.55 (CSAH 8)       | 6.5            | 9          | 19.9                 | 26.2 <sup>1</sup> | --       | 10.0   |
| 2           | CSAH 8  | 0+00 (Polk Co Line) to 105+98.47 (TH 92) | 11.875         | 11         | 27.5                 | 27.7 <sup>1</sup> | --       | 10.0   |
| 3           | CSAH 11 | 0+31(Polk Co Line) to 20+50              | 5.75           | 14         | 15.8                 | --                | --       | 10.0   |
| 3           | CSAH 11 | 20+50 to 82+75                           | 3.5            | 14         | 8.5                  | --                | --       | 8.1    |
| 3           | CSAH 11 | 82+75 to 151+75                          | 5.75           | 14         | 16.1                 | --                | --       | 10.0   |
| 3           | CSAH 11 | 151+75 to 182+00                         | 3.5            | 14         | 10.4                 | --                | --       | 10.0   |
| 3           | CSAH 11 | 182+00 to 345+00                         | 5.75           | 14         | 12.6                 | --                | --       | 10.0   |
| 3           | CSAH 11 | 345+00 to 368+00                         | 3.5            | 14         | 10.5                 | --                | --       | 8.6    |
| 3           | CSAH 11 | 368+00 to 392+68                         | 5.75           | 14         | 13.0                 | --                | --       | 10.0   |

| Test Option | Section | Termini  | Total AC (in.) | Daily ESAL | FWD Analysis Results |       |          |        |
|-------------|---------|--|----------------|------------|----------------------|-------|----------|--------|
|             |         |  |                |            | Effr85               | EGE85 | 9-Ton OL | TONN85 |
| 3           | CSAH 11 | 392+68 to 421+38                               | 4.25           | 18         | 10.4                 | --    | --       | 10.0   |
| 3           | CSAH 13 | URBAN SECTION                                  | 4.0            | 26         | 11.1                 | --    | --       | 8.4    |
| 3           | CSAH 13 | 618+00 (S of CSAH 19) to 415+00 (N of CSAH 18) | 4.0            | 14         | 12.1                 | --    | --       | 10.0   |
| 3           | CSAH 13 | N of CSAH 18 to Polk Co Line                   | 8.0            | 7          | 13.9                 | --    | --       | 10.0   |
| 4           | CSAH 5  | 533+33 (Pennington Co Line) to 442+87          | 8.75           | 8          | 12.7                 | 28.5  | 0.0      | 10.0   |
| 4           | CSAH 5  | 442+87 to 420+04                               | 5.75           | 8          | 11.0                 | 22.2  | 0.0      | 10.0   |
| 4           | CSAH 5  | 420+04 to 312+00                               | 8.75           | 8          | 16.0                 | 28.9  | 0.0      | 10.0   |
| 4           | CSAH 5  | 312+00 to 96+00                                | 6.00           | 15         | 13.3                 | 26.6  | 0.0      | 10.0   |
| 4           | CSAH 5  | 96+00 to 86+00                                 | 3.00           | 15         | 14.0                 | 19.7  | 0.0      | 10.0   |
| 4           | CSAH 5  | 86+00 to 80+00 (TH 222)                        | 6.00           | 15         | 14.0                 | 26.9  | 0.0      | 10.0   |

<sup>1</sup>Derived from AASHTO EffSN; see discussion in C.1.d.

**C.1.d CSAH 7 and 8 (Fabric and Overlay)**

To compare pre- and post-construction testing for the 3.5" fabric and overlay completed on CSAH 7 and 8, Braun Intertec used methods derived by AASHTO for the backcalculation of EffSN from deflection data.

By many models, subgrade modulus is assumed strongest in the winter, weakest during spring thaw, and as slowly recovering in strength between these two seasons. In Minnesota, it is expected that subgrade modulus should be measurably higher in early November than in late June. This is part of the basis for the Mn/DOT Seasonal Correction Factors (SCF) table described in Section D.4. However, these factors are very general, which makes them difficult to apply for comparison on a specific roadbed when pavement thickness changes substantially. The AASHTO method was used to calculate the temperature corrected effective strength of the pavement structure above the subgrade, ideally minimizing the effect of seasonal variations in subgrade resilient modulus.

EffSN was calculated for the data collected prior to and following overlay for CSAH 7 and CSAH 8 to determine net change in structure resulting from the overlay, as well as any discernable structural change from the fabric. Net change in EffSN (15th percentile) following overlay was 1.48 on CSAH 7 and 1.12 on CSAH 8, a proportional difference of 62.8 and 32.8 percent, respectively. Assuming a structural layer coefficient of 0.44 for intact asphalt, these changes represent a net structural gain of 3.4 and 2.5 inches

| Test Option | Section | Termini  | Total AC (in.) | Daily ESAL | FWD Analysis Results |       |          |        |
|-------------|---------|--|----------------|------------|----------------------|-------|----------|--------|
|             |         |  |                |            | EfFR85               | EGE85 | 9-Ton OL | TONN85 |
| 3           | CSAH 11 | 392+68 to 421+38                               | 4.25           | 18         | 10.4                 | --    | --       | 10.0   |
| 3           | CSAH 13 | URBAN SECTION                                  | 4.0            | 26         | 11.1                 | --    | --       | 8.4    |
| 3           | CSAH 13 | 618+00 (S of CSAH 19) to 415+00 (N of CSAH 18) | 4.0            | 14         | 12.1                 | --    | --       | 10.0   |
| 3           | CSAH 13 | N of CSAH 18 to Polk Co Line                   | 8.0            | 7          | 13.9                 | --    | --       | 10.0   |
| 4           | CSAH 5  | 533+33 (Pennington Co Line) to 442+87          | 8.75           | 8          | 12.7                 | 28.5  | 0.0      | 10.0   |
| 4           | CSAH 5  | 442+87 to 420+04                               | 5.75           | 8          | 11.0                 | 22.2  | 0.0      | 10.0   |
| 4           | CSAH 5  | 420+04 to 312+00                               | 8.75           | 8          | 16.0                 | 28.9  | 0.0      | 10.0   |
| 4           | CSAH 5  | 312+00 to 96+00                                | 6.00           | 15         | 13.3                 | 26.6  | 0.0      | 10.0   |
| 4           | CSAH 5  | 96+00 to 86+00                                 | 3.00           | 15         | 14.0                 | 19.7  | 0.0      | 10.0   |
| 4           | CSAH 5  | 86+00 to 80+00 (TH 222)                        | 6.00           | 15         | 14.0                 | 26.9  | 0.0      | 10.0   |

<sup>1</sup>Derived from AASHTO EffSN; see discussion in C.1.d.

**C.1.d CSAH 7 and 8 (Fabric and Overlay)**

To compare pre- and post-construction testing for the 3.5" fabric and overlay completed on CSAH 7 and 8, Braun Intertec used methods derived by AASHTO for the backcalculation of EffSN from deflection data.

By many models, subgrade modulus is assumed strongest in the winter, weakest during spring thaw, and as slowly recovering in strength between these two seasons. In Minnesota, it is expected that subgrade modulus should be measurably higher in early November than in late June. This is part of the basis for the Mn/DOT Seasonal Correction Factors (SCF) table described in Section D.4. However, these factors are very general, which makes them difficult to apply for comparison on a specific roadbed when pavement thickness changes substantially. The AASHTO method was used to calculate the temperature corrected effective strength of the pavement structure above the subgrade, ideally minimizing the effect of seasonal variations in subgrade resilient modulus.

EffSN was calculated for the data collected prior to and following overlay for CSAH 7 and CSAH 8 to determine net change in structure resulting from the overlay, as well as any discernable structural change from the fabric. Net change in EffSN (15th percentile) following overlay was 1.48 on CSAH 7 and 1.12 on CSAH 8, a proportional difference of 62.8 and 32.8 percent, respectively. Assuming a structural layer coefficient of 0.44 for intact asphalt, these changes represent a net structural gain of 3.4 and 2.5 inches

- Effective R-values are in the range of or slightly higher than expected based on the assumed subgrade soil type (Soil Factor = 130). No areas of excessively low subgrade R-value are apparent in the data, nor were any areas of failed subgrade observed as indicated by pavement surface condition.
- Following the 3.5-inch overlay, EffSN (in asphalt equivalent) for CSAH 7 and 8 changed by 3.4 and 2.5 inches for CSAH 7 and 8, respectively. Percent change in EffSN between fabric and traditional overlay sections was nominal. After two tests, there appears to be no difference in effective structure between fabric and traditional sections.

We recommend the following:

- Re-test CSAH 7 and CSAH 8 under temperature and moisture conditions similar to those of one the first two tests to get a more direct comparison of structural criteria.
- For the sections of CSAH 5 from 80+00 to 96+00, we recommend mill-and-inlay to eliminate cracks and to increase granular equivalency between 86+00 and 90+00. Mill depth should be chosen to eliminate cracks in the upper asphalt layers (3 inches to the previous overlay interface). Between stations 96+00 and 312+00, there is a point where pavement surface condition worsens. Mill-and-inlay should be performed to eliminate cracks in the upper layers as surface conditions deteriorate in these sections.
- For the pavement sections of CSAH 5 from station 312+00 to the north county line, load capacity and surface condition are both adequate for the expected traffic volumes. As the frequency of cracks increases, application of a chip seal or thin asphalt overlay would help extend pavement life.
- Monitor the areas of potentially weak subgrade north of the bridge and near CSAH 9 on CSAH 13, and between station 20+50 and 82+75 on CSAH 11, for signs of pavement/subgrade degradation (C.1.b).
- Continue to monitor and perform routine maintenance of all pavement sections in the network.

#### **D. Basis of Deflection Data Analysis**

Our analysis is based on information collected in the field or furnished by personnel of the Red Lake County Highway Department. Spring season axle load recommendations are for an 85 percent reliability level based on recommended AASHTO design factors.

Braun Intertec Corporation - Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESAL: 9.0  
 Total AC: 6.5 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.55  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 7

From: 0+00 (TH 59)  
 To: 307+51.55 (CSAH 8)

| Location (feet) |       | Lane    | Time  | Pvm't. Surf. Temp. °F | Test Load (lb) | Sensor Readings, (mils) |       |      |      |      |      |      | Effective Subgrade R-value | Effective Granular Equiv. (in.) | 9-Ton Overlay Thickness (in.) | TQNN Maximum Axle Load Capacity (Tons) | Comments                     |
|-----------------|-------|---------|-------|-----------------------|----------------|-------------------------|-------|------|------|------|------|------|----------------------------|---------------------------------|-------------------------------|--|------------------------------|
| Left            | Right |         |       |                       |                | d(1)                    | d(2)  | d(3) | d(4) | d(5) | d(6) | d(7) |                            |                                 |                               |  |                              |
|                 |       |         |       |                       |                |                         |       |      |      |      |      |      |                            |                                 |                               |  | STATION 0+00 AT START OF PAV |
|                 | 200   | Right-1 | 7:49  | 33.8                  | 6922           | 7.61                    | 6.57  | 5.74 | 4.51 | 3.49 | 2.23 | 1.09 | 26.4                       | 20.4                            | 0.0                           | 10.0                                   |                              |
|                 | 200   | Right-1 | 7:49  | 33.8                  | 7032           | 7.59                    | 6.55  | 5.72 | 4.48 | 3.46 | 2.24 | 1.10 | 26.9                       | 20.4                            | 0.0                           | 10.0                                   |                              |
|                 | 200   | Right-1 | 7:49  | 33.8                  | 10302          | 11.11                   | 9.56  | 8.33 | 6.56 | 5.15 | 3.33 | 1.67 | 26.6                       | 22.3                            | 0.0                           | 10.0                                   |                              |
| 200             |       | Left-1  | 10:27 | 37.5                  | 6583           | 6.31                    | 5.44  | 4.83 | 3.93 | 3.19 | 2.06 | 1.02 | 28.8                       | 21.6                            | 0.0                           | 10.0                                   |                              |
| 200             |       | Left-1  | 10:27 | 37.5                  | 6627           | 6.27                    | 5.41  | 4.81 | 3.90 | 3.15 | 2.04 | 1.00 | 29.4                       | 21.4                            | 0.0                           | 10.0                                   |                              |
| 200             |       | Left-1  | 10:27 | 37.5                  | 9635           | 9.37                    | 7.97  | 7.11 | 5.81 | 4.75 | 3.12 | 1.57 | 27.8                       | 23.5                            | 0.0                           | 10.0                                   |                              |
|                 | 600   | Right-1 | 7:50  | 33.8                  | 7043           | 6.25                    | 5.50  | 5.02 | 4.29 | 3.58 | 2.51 | 1.29 | 26.3                       | 24.3                            | 0.0                           | 10.0                                   |                              |
|                 | 600   | Right-1 | 7:50  | 33.8                  | 6999           | 6.20                    | 5.46  | 4.96 | 4.24 | 3.54 | 2.49 | 1.28 | 26.4                       | 24.3                            | 0.0                           | 10.0                                   |                              |
|                 | 600   | Right-1 | 7:50  | 33.8                  | 10356          | 9.35                    | 8.21  | 7.52 | 6.44 | 5.41 | 3.81 | 1.94 | 25.4                       | 26.3                            | 0.0                           | 10.0                                   |                              |
|                 | 1200  | Right-1 | 7:53  | 33.7                  | 7163           | 6.71                    | 5.81  | 5.26 | 4.44 | 3.71 | 2.57 | 1.29 | 25.8                       | 23.8                            | 0.0                           | 10.0                                   |                              |
|                 | 1200  | Right-1 | 7:53  | 33.7                  | 7043           | 6.58                    | 5.71  | 5.16 | 4.36 | 3.63 | 2.52 | 1.29 | 25.9                       | 23.7                            | 0.0                           | 10.0                                   |                              |
|                 | 1200  | Right-1 | 7:53  | 33.7                  | 10455          | 9.91                    | 8.61  | 7.79 | 6.54 | 5.49 | 3.83 | 1.93 | 25.2                       | 25.7                            | 0.0                           | 10.0                                   |                              |
| 1400            |       | Left-1  | 10:26 | 37.4                  | 6573           | 6.95                    | 6.17  | 5.65 | 4.80 | 4.04 | 2.85 | 1.49 | 20.8                       | 25.8                            | 0.0                           | 10.0                                   |                              |
| 1400            |       | Left-1  | 10:26 | 37.4                  | 6551           | 6.87                    | 6.14  | 5.60 | 4.76 | 3.99 | 2.81 | 1.48 | 21.0                       | 25.7                            | 0.0                           | 10.0                                   |                              |
| 1400            |       | Left-1  | 10:26 | 37.4                  | 9546           | 10.17                   | 9.00  | 8.24 | 7.04 | 5.94 | 4.22 | 2.19 | 20.6                       | 27.5                            | 0.0                           | 10.0                                   |                              |
|                 | 1600  | Right-1 | 7:54  | 33.6                  | 6835           | 7.33                    | 6.14  | 5.54 | 4.57 | 3.75 | 2.52 | 1.21 | 24.0                       | 22.6                            | 0.0                           | 10.0                                   |                              |
|                 | 1600  | Right-1 | 7:54  | 33.6                  | 6780           | 7.19                    | 6.06  | 5.43 | 4.49 | 3.70 | 2.48 | 1.20 | 24.3                       | 22.5                            | 0.0                           | 10.0                                   |                              |
|                 | 1600  | Right-1 | 7:54  | 33.6                  | 9941           | 10.67                   | 8.95  | 8.07 | 6.70 | 5.53 | 3.74 | 1.79 | 23.6                       | 24.5                            | 0.0                           | 10.0                                   |                              |
|                 | 2000  | Right-1 | 7:55  | 33.7                  | 6824           | 7.17                    | 6.32  | 5.72 | 4.86 | 4.01 | 2.76 | 1.43 | 22.3                       | 24.4                            | 0.0                           | 10.0                                   |                              |
|                 | 2000  | Right-1 | 7:55  | 33.7                  | 6758           | 7.07                    | 6.22  | 5.62 | 4.73 | 3.91 | 2.70 | 1.41 | 22.5                       | 24.2                            | 0.0                           | 10.0                                   |                              |
|                 | 2000  | Right-1 | 7:55  | 33.7                  | 9875           | 10.52                   | 9.23  | 8.35 | 7.05 | 5.84 | 4.06 | 2.11 | 21.8                       | 26.0                            | 0.0                           | 10.0                                   |                              |
| 2400            |       | Left-1  | 10:25 | 37.3                  | 6529           | 7.13                    | 5.94  | 5.27 | 4.27 | 3.44 | 2.25 | 1.10 | 25.2                       | 21.6                            | 0.0                           | 10.0                                   |                              |
| 2400            |       | Left-1  | 10:25 | 37.3                  | 6529           | 7.11                    | 5.94  | 5.26 | 4.27 | 3.44 | 2.25 | 1.09 | 25.2                       | 21.6                            | 0.0                           | 10.0                                   |                              |
| 2400            |       | Left-1  | 10:25 | 37.3                  | 9613           | 10.37                   | 8.68  | 7.72 | 6.30 | 5.11 | 3.40 | 1.65 | 24.8                       | 23.6                            | 0.0                           | 10.0                                   |                              |
|                 | 2800  | Right-1 | 7:56  | 33.8                  | 6846           | 6.43                    | 5.72  | 5.20 | 4.37 | 3.69 | 2.51 | 1.30 | 25.2                       | 24.1                            | 0.0                           | 10.0                                   |                              |
|                 | 2800  | Right-1 | 7:56  | 33.8                  | 6769           | 6.39                    | 5.69  | 5.16 | 4.33 | 3.67 | 2.49 | 1.29 | 25.1                       | 24.1                            | 0.0                           | 10.0                                   |                              |
|                 | 2800  | Right-1 | 7:56  | 33.8                  | 9821           | 9.39                    | 8.35  | 7.58 | 6.43 | 5.36 | 3.74 | 1.92 | 24.2                       | 26.0                            | 0.0                           | 10.0                                   |                              |
|                 | 3200  | Right-1 | 7:57  | 33.6                  | 6769           | 7.31                    | 6.54  | 6.00 | 5.16 | 4.34 | 3.04 | 1.60 | 19.9                       | 25.9                            | 0.0                           | 10.0                                   |                              |
|                 | 3200  | Right-1 | 7:57  | 33.6                  | 6704           | 7.22                    | 6.46  | 5.92 | 5.09 | 4.28 | 3.01 | 1.60 | 20.0                       | 25.9                            | 0.0                           | 10.0                                   |                              |
|                 | 3200  | Right-1 | 7:57  | 33.6                  | 9842           | 10.77                   | 9.62  | 8.80 | 7.56 | 6.37 | 4.51 | 2.37 | 19.5                       | 27.6                            | 0.0                           | 10.0                                   |                              |
| 3200            |       | Left-1  | 10:23 | 37.6                  | 6583           | 7.65                    | 6.81  | 6.20 | 5.22 | 4.33 | 2.97 | 1.51 | 19.5                       | 25.3                            | 0.0                           | 10.0                                   |                              |
| 3200            |       | Left-1  | 10:23 | 37.6                  | 6529           | 7.57                    | 6.74  | 6.13 | 5.19 | 4.29 | 2.96 | 1.52 | 19.4                       | 25.3                            | 0.0                           | 10.0                                   |                              |
| 3200            |       | Left-1  | 10:23 | 37.6                  | 9624           | 11.34                   | 10.06 | 9.18 | 7.77 | 6.48 | 4.50 | 2.28 | 18.8                       | 27.2                            | 0.0                           | 10.0                                   |                              |
|                 | 3800  | Right-1 | 7:58  | 34.3                  | 6824           | 7.14                    | 6.30  | 5.76 | 4.83 | 4.12 | 2.97 | 1.57 | 20.7                       | 25.7                            | 0.0                           | 10.0                                   |                              |
|                 | 3800  | Right-1 | 7:58  | 34.3                  | 6769           | 7.07                    | 6.20  | 5.67 | 4.84 | 4.10 | 2.91 | 1.57 | 21.0                       | 25.5                            | 0.0                           | 10.0                                   |                              |
|                 | 3800  | Right-1 | 7:58  | 34.3                  | 9886           | 10.41                   | 9.19  | 8.39 | 7.18 | 6.06 | 4.33 | 2.29 | 20.6                       | 27.3                            | 0.0                           | 10.0                                   |                              |
| 3800            |       | Left-1  | 10:22 | 39.1                  | 6540           | 6.07                    | 5.37  | 4.88 | 4.20 | 3.56 | 2.56 | 1.44 | 23.7                       | 25.7                            | 0.0                           | 10.0                                   |                              |
| 3800            |       | Left-1  | 10:22 | 39.1                  | 6551           | 6.05                    | 5.37  | 4.86 | 4.18 | 3.54 | 2.54 | 1.47 | 23.9                       | 25.6                            | 0.0                           | 10.0                                   |                              |
| 3800            |       | Left-1  | 10:22 | 39.1                  | 9646           | 9.13                    | 7.97  | 7.27 | 6.26 | 5.31 | 3.86 | 2.17 | 23.1                       | 27.4                            | 0.0                           | 10.0                                   |                              |
|                 | 4200  | Right-1 | 7:59  | 33.6                  | 6780           | 6.82                    | 6.21  | 5.51 | 4.59 | 3.78 | 2.58 | 1.28 | 23.9                       | 23.8                            | 0.0                           | 10.0                                   |                              |
|                 | 4200  | Right-1 | 7:59  | 33.6                  | 6726           | 6.67                    | 6.06  | 5.40 | 4.50 | 3.69 | 2.53 | 1.25 | 24.2                       | 23.7                            | 0.0                           | 10.0                                   |                              |
|                 | 4200  | Right-1 | 7:59  | 33.6                  | 9842           | 9.91                    | 8.97  | 8.01 | 6.67 | 5.52 | 3.80 | 1.90 | 23.5                       | 25.6                            | 0.0                           | 10.0                                   |                              |
| 4600            |       | Left-1  | 10:21 | 37.4                  | 6605           | 5.80                    | 5.26  | 4.78 | 4.04 | 3.39 | 2.36 | 1.14 | 26.3                       | 24.7                            | 0.0                           | 10.0                                   |                              |
| 4600            |       | Left-1  | 10:21 | 37.4                  | 6616           | 5.79                    | 5.24  | 4.76 | 4.01 | 3.37 | 2.34 | 1.13 | 26.6                       | 24.6                            | 0.0                           | 10.0                                   |                              |
| 4600            |       | Left-1  | 10:21 | 37.4                  | 9722           | 8.63                    | 7.75  | 7.07 | 6.02 | 5.08 | 3.57 | 1.72 | 25.5                       | 26.6                            | 0.0                           | 10.0                                   |                              |
|                 | 4800  | Right-1 | 8:01  | 33.5                  | 6780           | 7.03                    | 6.11  | 5.57 | 4.72 | 3.94 | 2.74 | 1.42 | 22.4                       | 24.5                            | 0.0                           | 10.0                                   |                              |
|                 | 4800  | Right-1 | 8:01  | 33.5                  | 6693           | 6.87                    | 6.03  | 5.47 | 4.65 | 3.88 | 2.72 | 1.42 | 22.3                       | 24.6                            | 0.0                           | 10.0                                   |                              |
|                 | 4800  | Right-1 | 8:01  | 33.5                  | 9777           | 10.12                   | 8.85  | 8.06 | 6.85 | 5.74 | 4.01 | 2.10 | 22.0                       | 26.3                            | 0.0                           | 10.0                                   |                              |
|                 | 5200  | Right-1 | 8:02  | 33.7                  | 6758           | 7.30                    | 6.55  | 6.02 | 5.16 | 4.35 | 3.11 | 1.59 | 19.4                       | 26.3                            | 0.0                           | 10.0                                   |                              |
|                 | 5200  | Right-1 | 8:02  | 33.7                  | 6627           | 7.17                    | 6.43  | 5.91 | 5.06 | 4.29 | 3.07 | 1.59 | 19.3                       | 26.3                            | 0.0                           | 10.0                                   |                              |
|                 | 5200  | Right-1 | 8:02  | 33.7                  | 9799           | 10.68                   | 9.57  | 8.76 | 7.54 | 6.39 | 4.60 | 2.37 | 19.1                       | 28.0                            | 0.0                           | 10.0                                   |                              |
| 5400            |       | Left-1  | 10:20 | 37.4                  | 6627           | 6.78                    | 6.18  | 5.76 | 4.84 | 4.04 | 2.87 | 1.54 | 20.9                       | 26.2                            | 0.0                           | 10.0                                   |                              |
| 5400            |       | Left-1  | 10:20 | 37.4                  | 6551           | 6.64                    | 6.10  | 5.65 | 4.76 | 3.98 | 2.84 | 1.55 | 20.9                       | 26.3                            | 0.0                           | 10.0                                   |                              |
| 5400            |       | Left-1  | 10:20 | 37.4                  | 9624           | 9.93                    | 9.06  | 8.41 | 7.11 | 5.97 | 4.28 | 2.31 | 20.4                       | 28.0                            | 0.0                           | 10.0                                   |                              |
|                 | 5800  | Right-1 | 8:03  | 33.5                  | 6780           | 6.34                    | 5.70  | 5.30 | 4.65 | 4.02 | 3.00 | 1.68 | 20.6                       | 27.6                            | 0.0                           | 10.0                                   |                              |
|                 | 5800  | Right-1 | 8:03  | 33.5                  | 6682           | 6.23                    | 5.61  | 5.20 | 4.56 | 3.95 | 2.97 | 1.67 | 20.5                       | 27.7                            | 0.0                           | 10.0                                   |                              |
|                 | 5800  | Right-1 | 8:03  | 33.5                  | 9831           | 9.12                    | 8.24  | 7.64 | 6.74 | 5.87 | 4.42 | 2.47 | 20.2                       | 29.7                            | 0.0                           | 10.0                                   |                              |

Braun Intertec Corporation - Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESALs: 9.0  
 Total AC: 6.5 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.55  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 7

From: 0+00 (TH 59)  
 To: 307+51.55 (CSAH 8)

| Location (feet) | Lane    | Time  | Pvm/L Surf. Temp. °F | Test Load (lb) | Sensor Readings, (mils) |       |      |      |      |      |      | Effective Subgrade R-value | Effective Granular Equiv. (in.) | 9-Ton Overlay Thickness (in.) | TONN Maximum Axle Load Capacity (Tons) | Comments |
|-----------------|---------|-------|----------------------|----------------|-------------------------|-------|------|------|------|------|------|----------------------------|---------------------------------|-------------------------------|--|----------|
|                 |         |       |                      |                | d(1)                    | d(2)  | d(3) | d(4) | d(5) | d(6) | d(7) |                            |                                 |                               |  |          |
| 6200            | Right-1 | 8:04  | 33.6                 | 6946           | 5.82                    | 5.30  | 4.91 | 4.31 | 3.70 | 2.77 | 1.50 | 23.0                       | 27.2                            | 0.0                           | 10.0                                   |          |
| 6200            | Right-1 | 8:04  | 33.6                 | 6726           | 5.73                    | 5.20  | 4.79 | 4.21 | 3.62 | 2.70 | 1.48 | 23.2                       | 26.9                            | 0.0                           | 10.0                                   |          |
| 6200            | Right-1 | 8:04  | 33.6                 | 9930           | 8.45                    | 7.69  | 7.11 | 6.25 | 5.41 | 4.06 | 2.18 | 22.7                       | 29.0                            | 0.0                           | 10.0                                   |          |
| 6600            | Right-1 | 8:05  | 33.4                 | 6748           | 6.68                    | 5.91  | 5.36 | 4.50 | 3.74 | 2.55 | 1.19 | 24.1                       | 23.9                            | 0.0                           | 10.0                                   |          |
| 6600            | Right-1 | 8:05  | 33.4                 | 6693           | 6.58                    | 5.82  | 5.28 | 4.43 | 3.68 | 2.51 | 1.17 | 24.4                       | 23.8                            | 0.0                           | 10.0                                   |          |
| 6600            | Right-1 | 8:05  | 33.4                 | 9908           | 9.81                    | 8.70  | 7.87 | 6.63 | 5.52 | 3.79 | 1.76 | 23.9                       | 25.7                            | 0.0                           | 10.0                                   |          |
| 6600            | Left-1  | 10:18 | 37.4                 | 6463           | 7.64                    | 6.39  | 5.67 | 4.68 | 3.82 | 2.58 | 1.28 | 21.6                       | 22.9                            | 0.0                           | 10.0                                   |          |
| 6600            | Left-1  | 10:18 | 37.4                 | 6662           | 7.62                    | 6.41  | 5.70 | 4.69 | 3.83 | 2.59 | 1.30 | 22.0                       | 23.0                            | 0.0                           | 10.0                                   |          |
| 6500            | Left-1  | 10:18 | 37.4                 | 9635           | 11.31                   | 9.44  | 8.40 | 6.96 | 5.70 | 3.88 | 1.96 | 21.5                       | 24.7                            | 0.0                           | 10.0                                   |          |
|                 | Right-1 | 8:07  | 33.6                 | 6769           | 8.80                    | 6.18  | 5.54 | 4.58 | 3.80 | 2.67 | 1.37 | 23.1                       | 24.4                            | 0.0                           | 10.0                                   |          |
| 7200            | Right-1 | 8:07  | 33.6                 | 6663           | 6.68                    | 6.11  | 5.46 | 4.66 | 3.78 | 2.65 | 1.37 | 23.0                       | 24.5                            | 0.0                           | 10.0                                   |          |
| 7200            | Right-1 | 8:07  | 33.6                 | 9810           | 9.91                    | 9.05  | 8.11 | 6.78 | 5.67 | 3.97 | 2.07 | 22.5                       | 26.4                            | 0.0                           | 10.0                                   |          |
| 7400            | Right-1 | 8:08  | 33.5                 | 6704           | 6.81                    | 6.02  | 5.50 | 4.70 | 3.97 | 2.79 | 1.39 | 21.8                       | 25.2                            | 0.0                           | 10.0                                   |          |
| 7400            | Right-1 | 8:08  | 33.5                 | 6758           | 6.78                    | 6.02  | 5.50 | 4.70 | 3.93 | 2.75 | 1.39 | 22.4                       | 25.0                            | 0.0                           | 10.0                                   |          |
| 7400            | Right-1 | 8:08  | 33.5                 | 9788           | 9.99                    | 8.87  | 8.11 | 6.95 | 5.87 | 4.14 | 2.08 | 21.4                       | 27.0                            | 0.0                           | 10.0                                   |          |
| 7400            | Left-1  | 10:17 | 37.2                 | 6540           | 7.04                    | 6.22  | 5.63 | 4.74 | 3.95 | 2.75 | 1.45 | 21.3                       | 24.9                            | 0.0                           | 10.0                                   |          |
| 7400            | Left-1  | 10:17 | 37.2                 | 6474           | 6.96                    | 6.14  | 5.56 | 4.69 | 3.92 | 2.73 | 1.45 | 21.3                       | 25.0                            | 0.0                           | 10.0                                   |          |
| 7400            | Left-1  | 10:17 | 37.2                 | 9625           | 10.31                   | 9.06  | 8.23 | 6.98 | 5.87 | 4.13 | 2.17 | 20.6                       | 26.9                            | 0.0                           | 10.0                                   |          |
|                 | Right-1 | 8:09  | 33.6                 | 6791           | 6.73                    | 5.94  | 5.39 | 4.54 | 3.76 | 2.55 | 1.25 | 24.3                       | 23.8                            | 0.0                           | 10.0                                   |          |
| 8000            | Right-1 | 8:09  | 33.6                 | 6726           | 6.64                    | 5.86  | 5.31 | 4.43 | 3.67 | 2.50 | 1.24 | 24.5                       | 23.6                            | 0.0                           | 10.0                                   |          |
| 8000            | Right-1 | 8:09  | 33.6                 | 9853           | 9.87                    | 8.72  | 7.91 | 6.85 | 5.52 | 3.78 | 1.84 | 23.7                       | 25.6                            | 0.0                           | 10.0                                   |          |
| 8200            | Left-1  | 10:16 | 37.3                 | 6529           | 5.63                    | 4.93  | 4.48 | 3.80 | 3.15 | 2.16 | 1.07 | 28.5                       | 23.5                            | 0.0                           | 10.0                                   |          |
| 8200            | Left-1  | 10:16 | 37.3                 | 6485           | 5.58                    | 4.89  | 4.44 | 3.76 | 3.11 | 2.13 | 1.07 | 28.7                       | 23.3                            | 0.0                           | 10.0                                   |          |
| 8200            | Left-1  | 10:16 | 37.3                 | 9525           | 8.21                    | 7.23  | 6.59 | 5.60 | 4.68 | 3.25 | 1.63 | 27.7                       | 25.5                            | 0.0                           | 10.0                                   |          |
|                 | Right-1 | 8:10  | 33.8                 | 6671           | 6.92                    | 5.93  | 5.32 | 4.33 | 3.47 | 2.28 | 1.18 | 25.9                       | 21.7                            | 0.0                           | 10.0                                   |          |
| 8400            | Right-1 | 8:10  | 33.8                 | 6715           | 6.85                    | 5.93  | 5.31 | 4.33 | 3.47 | 2.29 | 1.19 | 26.2                       | 21.8                            | 0.0                           | 10.0                                   |          |
| 8400            | Right-1 | 8:10  | 33.8                 | 9863           | 10.15                   | 8.76  | 7.89 | 6.44 | 5.19 | 3.42 | 1.78 | 25.7                       | 23.7                            | 0.0                           | 10.0                                   |          |
| 9200            | Right-1 | 8:12  | 33.8                 | 6769           | 7.00                    | 6.24  | 5.78 | 4.94 | 4.18 | 2.91 | 1.37 | 21.0                       | 25.7                            | 0.0                           | 10.0                                   |          |
| 9200            | Right-1 | 8:12  | 33.8                 | 6704           | 6.90                    | 6.19  | 5.70 | 4.88 | 4.13 | 2.88 | 1.34 | 21.1                       | 25.7                            | 0.0                           | 10.0                                   |          |
| 9200            | Right-1 | 8:12  | 33.8                 | 9756           | 10.33                   | 9.22  | 8.51 | 7.32 | 6.22 | 4.36 | 2.04 | 20.1                       | 27.6                            | 0.0                           | 10.0                                   |          |
| 9400            | Left-1  | 10:15 | 37.2                 | 6694           | 7.36                    | 6.67  | 6.11 | 5.21 | 4.41 | 3.09 | 1.57 | 19.0                       | 26.5                            | 0.0                           | 10.0                                   |          |
| 9400            | Left-1  | 10:15 | 37.2                 | 6594           | 7.36                    | 6.65  | 6.10 | 5.22 | 4.42 | 3.10 | 1.58 | 18.9                       | 26.6                            | 0.0                           | 10.0                                   |          |
| 9400            | Left-1  | 10:15 | 37.2                 | 9635           | 10.93                   | 9.83  | 9.02 | 7.74 | 6.60 | 4.67 | 2.38 | 18.2                       | 28.4                            | 0.0                           | 10.0                                   |          |
|                 | Right-1 | 8:15  | 33.9                 | 6693           | 7.65                    | 6.83  | 6.22 | 5.31 | 4.45 | 3.14 | 1.67 | 18.8                       | 25.8                            | 0.0                           | 10.0                                   |          |
| 9800            | Right-1 | 8:15  | 33.9                 | 6748           | 7.69                    | 6.90  | 6.28 | 5.36 | 4.52 | 3.19 | 1.69 | 18.7                       | 26.1                            | 0.0                           | 10.0                                   |          |
| 9800            | Right-1 | 8:15  | 33.9                 | 9799           | 11.19                   | 10.04 | 9.14 | 7.81 | 6.61 | 4.69 | 2.46 | 18.5                       | 27.8                            | 0.0                           | 10.0                                   |          |
| 10400           | Right-1 | 8:16  | 34.2                 | 6737           | 6.54                    | 5.84  | 5.33 | 4.55 | 3.80 | 2.69 | 1.40 | 23.0                       | 25.1                            | 0.0                           | 10.0                                   |          |
| 10400           | Right-1 | 8:16  | 34.2                 | 6798           | 6.50                    | 5.80  | 5.28 | 4.48 | 3.76 | 2.65 | 1.39 | 23.5                       | 24.9                            | 0.0                           | 10.0                                   |          |
| 10400           | Right-1 | 8:16  | 34.2                 | 9810           | 9.64                    | 8.53  | 7.78 | 6.65 | 5.56 | 3.97 | 2.07 | 22.6                       | 26.8                            | 0.0                           | 10.0                                   |          |
| 10800           | Left-1  | 10:13 | 37.1                 | 6627           | 6.65                    | 5.88  | 5.37 | 4.53 | 3.80 | 2.67 | 1.34 | 22.6                       | 25.1                            | 0.0                           | 10.0                                   |          |
| 10800           | Left-1  | 10:13 | 37.1                 | 6474           | 6.53                    | 5.77  | 5.26 | 4.45 | 3.72 | 2.62 | 1.33 | 22.5                       | 25.0                            | 0.0                           | 10.0                                   |          |
| 10800           | Left-1  | 10:13 | 37.1                 | 9591           | 9.81                    | 8.65  | 7.89 | 6.69 | 5.63 | 3.95 | 2.01 | 22.0                       | 26.8                            | 0.0                           | 10.0                                   |          |
|                 | Right-1 | 8:18  | 34.5                 | 6693           | 6.72                    | 6.04  | 5.68 | 4.86 | 4.22 | 3.11 | 1.72 | 19.4                       | 27.6                            | 0.0                           | 10.0                                   |          |
| 11000           | Right-1 | 8:18  | 34.5                 | 6737           | 6.74                    | 6.07  | 5.70 | 4.85 | 4.24 | 3.11 | 1.76 | 19.6                       | 27.5                            | 0.0                           | 10.0                                   |          |
| 11000           | Right-1 | 8:18  | 34.5                 | 9821           | 9.93                    | 8.88  | 8.34 | 7.17 | 6.22 | 4.62 | 2.57 | 19.1                       | 29.3                            | 0.0                           | 10.0                                   |          |
| 11400           | Right-1 | 8:19  | 34.2                 | 6737           | 5.99                    | 5.23  | 4.72 | 3.93 | 3.25 | 2.17 | 1.00 | 28.9                       | 22.5                            | 0.0                           | 10.0                                   |          |
| 11400           | Right-1 | 8:19  | 34.2                 | 6693           | 5.95                    | 5.17  | 4.69 | 3.90 | 3.20 | 2.15 | 1.00 | 29.0                       | 22.4                            | 0.0                           | 10.0                                   |          |
| 11400           | Right-1 | 8:19  | 34.2                 | 9853           | 8.85                    | 7.72  | 6.99 | 5.86 | 4.86 | 3.27 | 1.52 | 28.1                       | 24.5                            | 0.0                           | 10.0                                   |          |
| 11400           | Left-1  | 10:12 | 37.4                 | 6583           | 6.51                    | 5.66  | 5.09 | 4.17 | 3.41 | 2.20 | 1.06 | 26.9                       | 22.3                            | 0.0                           | 10.0                                   |          |
| 11400           | Left-1  | 10:12 | 37.4                 | 6594           | 6.45                    | 5.63  | 5.06 | 4.15 | 3.39 | 2.19 | 1.07 | 27.2                       | 22.3                            | 0.0                           | 10.0                                   |          |
| 11400           | Left-1  | 10:12 | 37.4                 | 9591           | 9.60                    | 8.28  | 7.48 | 6.19 | 5.06 | 3.34 | 1.62 | 26.0                       | 24.4                            | 0.0                           | 10.0                                   |          |
|                 | Right-1 | 8:20  | 34.5                 | 6715           | 6.48                    | 5.74  | 5.30 | 4.50 | 3.76 | 2.65 | 1.30 | 23.3                       | 25.0                            | 0.0                           | 10.0                                   |          |
| 11800           | Right-1 | 8:20  | 34.5                 | 6693           | 6.38                    | 5.72  | 5.26 | 4.46 | 3.73 | 2.63 | 1.29 | 23.5                       | 25.1                            | 0.0                           | 10.0                                   |          |
| 11800           | Right-1 | 8:20  | 34.5                 | 9765           | 9.49                    | 8.48  | 7.80 | 6.66 | 5.61 | 3.98 | 1.98 | 22.5                       | 27.1                            | 0.0                           | 10.0                                   |          |
| 12200           | Left-1  | 10:11 | 37.8                 | 6562           | 6.28                    | 5.64  | 5.16 | 4.41 | 3.69 | 2.56 | 1.22 | 23.6                       | 25.3                            | 0.0                           | 10.0                                   |          |
| 12200           | Left-1  | 10:11 | 37.8                 | 6594           | 6.30                    | 5.65  | 5.17 | 4.42 | 3.70 | 2.58 | 1.27 | 23.6                       | 25.3                            | 0.0                           | 10.0                                   |          |
| 12200           | Left-1  | 10:11 | 37.8                 | 9733           | 9.45                    | 8.37  | 7.69 | 6.57 | 5.54 | 3.90 | 1.91 | 22.9                       | 27.1                            | 0.0                           | 10.0                                   |          |
|                 | Right-1 | 8:21  | 34.3                 | 6704           | 6.47                    | 5.72  | 5.22 | 4.42 | 3.69 | 2.59 | 1.25 | 23.8                       | 24.6                            | 0.0                           | 10.0                                   |          |



Braun Intertec Corporation - Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESALs: 9.0  
 Total AC: 6.5 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.55  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 7

From: 0+00 (TH 59)  
 To: 307+51.55 (CSAH 8)

| Location<br>(feet) | Lane    | Time  | Pvm'l<br>Surf.<br>Temp. | Test<br>Load<br>(lb) | Sensor Readings, (mil) |       |      |      |      |      |      |      | Effective<br>Subgrade<br>R-value | Effective<br>Granular<br>Equiv.<br>(in.) | 9-Ton<br>Overlay<br>Thickness<br>(in.) | TONN<br>Maximum<br>Axle Load<br>Capacity<br>(Tons) | Comments |
|--------------------|---------|-------|-------------------------|----------------------|------------------------|-------|------|------|------|------|------|------|----------------------------------|--|--|--|----------|
|                    |         |       |                         |                      | d(1)                   | d(2)  | d(3) | d(4) | d(5) | d(6) | d(7) | d(8) |                                  |  |  |  |          |
| 12400              | Right-1 | 8:21  | 34.3                    | 6649                 | 6.33                   | 5.63  | 5.15 | 4.37 | 3.68 | 2.57 | 1.24 | 23.9 | 24.8                             | 0.0                                      | 10.0                                   |  |          |
| 12400              | Right-1 | 8:21  | 34.3                    | 9777                 | 9.51                   | 8.39  | 7.69 | 6.56 | 5.54 | 3.89 | 1.89 | 23.1 | 26.6                             | 0.0                                      | 10.0                                   |  |          |
| 12800              | Right-1 | 8:22  | 34.2                    | 6671                 | 6.54                   | 5.74  | 5.17 | 4.36 | 3.61 | 2.46 | 1.17 | 24.8 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 12800              | Right-1 | 8:22  | 34.2                    | 6693                 | 6.51                   | 5.74  | 5.19 | 4.35 | 3.59 | 2.44 | 1.17 | 25.1 | 23.5                             | 0.0                                      | 10.0                                   |  |          |
| 12800              | Right-1 | 8:22  | 34.2                    | 9799                 | 9.68                   | 8.48  | 7.68 | 6.45 | 5.36 | 3.68 | 1.76 | 24.3 | 25.4                             | 0.0                                      | 10.0                                   |  |          |
| 12800              | Left-1  | 10:10 | 37.3                    | 6605                 | 6.61                   | 5.79  | 5.17 | 4.31 | 3.54 | 2.37 | 1.12 | 25.2 | 23.2                             | 0.0                                      | 10.0                                   |  |          |
| 12800              | Left-1  | 10:10 | 37.3                    | 6562                 | 6.51                   | 5.71  | 5.11 | 4.27 | 3.50 | 2.35 | 1.11 | 25.3 | 23.3                             | 0.0                                      | 10.0                                   |  |          |
| 12800              | Left-1  | 10:10 | 37.3                    | 9646                 | 9.58                   | 8.45  | 7.59 | 6.36 | 5.26 | 3.57 | 1.70 | 24.6 | 25.4                             | 0.0                                      | 10.0                                   |  |          |
| 13200              | Left-1  | 10:09 | 37.2                    | 6638                 | 6.21                   | 5.52  | 4.98 | 4.17 | 3.47 | 2.35 | 1.08 | 26.1 | 23.8                             | 0.0                                      | 10.0                                   |  |          |
| 13200              | Left-1  | 10:09 | 37.2                    | 6616                 | 6.13                   | 5.43  | 4.91 | 4.11 | 3.41 | 2.30 | 1.09 | 26.6 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 13200              | Left-1  | 10:09 | 37.2                    | 9589                 | 9.13                   | 8.10  | 7.35 | 6.19 | 5.16 | 3.52 | 1.65 | 25.4 | 25.7                             | 0.0                                      | 10.0                                   |  |          |
| 13400              | Right-1 | 8:23  | 34.2                    | 6726                 | 6.37                   | 5.65  | 5.16 | 4.39 | 3.68 | 2.54 | 1.20 | 24.5 | 24.5                             | 0.0                                      | 10.0                                   |  |          |
| 13400              | Right-1 | 8:23  | 34.2                    | 6693                 | 6.29                   | 5.60  | 5.11 | 4.35 | 3.64 | 2.52 | 1.20 | 24.6 | 24.5                             | 0.0                                      | 10.0                                   |  |          |
| 13400              | Right-1 | 8:23  | 34.2                    | 9788                 | 9.39                   | 8.30  | 7.61 | 6.50 | 5.46 | 3.80 | 1.80 | 23.7 | 28.4                             | 0.0                                      | 10.0                                   |  |          |
| 13800              | Right-1 | 8:24  | 34.3                    | 6682                 | 6.48                   | 5.81  | 5.35 | 4.62 | 3.91 | 2.82 | 1.45 | 21.8 | 26.1                             | 0.0                                      | 10.0                                   |  |          |
| 13800              | Right-1 | 8:24  | 34.3                    | 6638                 | 6.39                   | 5.73  | 5.25 | 4.52 | 3.83 | 2.75 | 1.43 | 22.3 | 25.8                             | 0.0                                      | 10.0                                   |  |          |
| 13800              | Right-1 | 8:24  | 34.3                    | 9788                 | 9.44                   | 8.44  | 7.73 | 6.65 | 5.65 | 4.12 | 2.12 | 21.9 | 27.7                             | 0.0                                      | 10.0                                   |  |          |
| 14400              | Right-1 | 8:25  | 34.6                    | 6627                 | 7.68                   | 7.06  | 6.46 | 5.53 | 4.70 | 3.44 | 1.98 | 16.9 | 27.5                             | 0.0                                      | 10.0                                   |  |          |
| 14400              | Right-1 | 8:25  | 34.6                    | 6583                 | 7.53                   | 6.98  | 6.39 | 5.48 | 4.65 | 3.41 | 1.97 | 17.0 | 27.7                             | 0.0                                      | 10.0                                   |  |          |
| 14400              | Right-1 | 8:25  | 34.6                    | 9602                 | 11.00                  | 10.19 | 9.35 | 8.05 | 6.86 | 5.07 | 2.86 | 16.6 | 29.6                             | 0.0                                      | 10.0                                   |  |          |
| 14400              | Left-1  | 10:07 | 37.4                    | 6905                 | 7.20                   | 6.45  | 5.89 | 5.04 | 4.21 | 2.93 | 1.53 | 20.1 | 25.8                             | 0.0                                      | 10.0                                   |  |          |
| 14400              | Left-1  | 10:07 | 37.4                    | 6562                 | 7.13                   | 6.39  | 5.63 | 4.99 | 4.18 | 2.91 | 1.54 | 20.2 | 25.8                             | 0.0                                      | 10.0                                   |  |          |
| 14400              | Left-1  | 10:07 | 37.4                    | 9646                 | 10.43                  | 9.39  | 8.58 | 7.36 | 6.19 | 4.36 | 2.30 | 19.8 | 27.8                             | 0.0                                      | 10.0                                   |  |          |
| 14800              | Right-1 | 8:26  | 34.5                    | 6638                 | 7.25                   | 6.38  | 5.79 | 4.87 | 4.06 | 2.79 | 1.41 | 21.2 | 24.5                             | 0.0                                      | 10.0                                   |  |          |
| 14800              | Right-1 | 8:26  | 34.5                    | 6616                 | 7.15                   | 6.33  | 5.76 | 4.83 | 4.04 | 2.79 | 1.40 | 21.2 | 24.7                             | 0.0                                      | 10.0                                   |  |          |
| 14800              | Right-1 | 8:26  | 34.5                    | 9678                 | 10.52                  | 9.31  | 8.45 | 7.14 | 5.98 | 4.19 | 2.09 | 20.7 | 26.6                             | 0.0                                      | 10.0                                   |  |          |
| 15200              | Left-1  | 10:06 | 37.2                    | 6573                 | 6.89                   | 5.94  | 5.47 | 4.62 | 3.91 | 2.87 | 1.49 | 20.8 | 26.3                             | 0.0                                      | 10.0                                   |  |          |
| 15200              | Left-1  | 10:06 | 37.2                    | 6583                 | 6.60                   | 5.91  | 5.45 | 4.59 | 3.88 | 2.88 | 1.50 | 20.9 | 26.4                             | 0.0                                      | 10.0                                   |  |          |
| 15200              | Left-1  | 10:06 | 37.2                    | 9656                 | 9.80                   | 8.71  | 8.06 | 6.82 | 5.78 | 4.28 | 2.22 | 20.5 | 28.1                             | 0.0                                      | 10.0                                   |  |          |
| 15400              | Right-1 | 8:28  | 34.7                    | 6638                 | 7.70                   | 7.05  | 6.24 | 5.07 | 4.07 | 2.76 | 1.36 | 21.0 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 15400              | Right-1 | 8:28  | 34.7                    | 6682                 | 7.65                   | 6.98  | 6.18 | 5.02 | 4.03 | 2.75 | 1.37 | 21.3 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 15400              | Right-1 | 8:28  | 34.7                    | 9678                 | 11.29                  | 10.24 | 9.11 | 7.43 | 6.01 | 4.11 | 2.03 | 20.6 | 25.4                             | 0.0                                      | 10.0                                   |  |          |
| 15800              | Right-1 | 8:29  | 34.6                    | 6715                 | 7.39                   | 6.56  | 5.99 | 5.12 | 4.29 | 3.01 | 1.48 | 19.9 | 25.6                             | 0.0                                      | 10.0                                   |  |          |
| 15800              | Right-1 | 8:29  | 34.6                    | 6638                 | 7.28                   | 6.47  | 5.89 | 5.04 | 4.24 | 2.98 | 1.47 | 19.9 | 25.7                             | 0.0                                      | 10.0                                   |  |          |
| 15800              | Right-1 | 8:29  | 34.6                    | 9711                 | 10.75                  | 9.52  | 8.71 | 7.45 | 6.31 | 4.45 | 2.17 | 19.4 | 27.5                             | 0.0                                      | 10.0                                   |  |          |
| 16400              | Right-1 | 8:30  | 34.8                    | 6704                 | 6.90                   | 5.86  | 5.40 | 4.67 | 3.96 | 2.82 | 1.42 | 21.9 | 26.1                             | 0.0                                      | 10.0                                   |  |          |
| 16400              | Right-1 | 8:30  | 34.8                    | 6704                 | 6.52                   | 5.89  | 5.42 | 4.70 | 3.98 | 2.83 | 1.44 | 21.8 | 26.2                             | 0.0                                      | 10.0                                   |  |          |
| 16400              | Right-1 | 8:30  | 34.8                    | 9810                 | 9.68                   | 8.69  | 7.99 | 6.93 | 5.88 | 4.22 | 2.13 | 21.3 | 27.9                             | 0.0                                      | 10.0                                   |  |          |
| 16400              | Left-1  | 10:05 | 37.2                    | 6583                 | 7.95                   | 7.09  | 6.46 | 5.48 | 4.52 | 3.13 | 1.58 | 18.4 | 25.6                             | 0.0                                      | 10.0                                   |  |          |
| 16400              | Left-1  | 10:05 | 37.2                    | 6540                 | 7.82                   | 6.93  | 6.33 | 5.33 | 4.40 | 3.06 | 1.56 | 18.7 | 25.4                             | 0.0                                      | 10.0                                   |  |          |
| 16400              | Left-1  | 10:05 | 37.2                    | 9589                 | 11.58                  | 10.28 | 9.39 | 7.98 | 6.63 | 4.64 | 2.34 | 18.0 | 27.4                             | 0.0                                      | 10.0                                   |  |          |
| 16800              | Right-1 | 8:31  | 34.7                    | 6649                 | 6.84                   | 5.95  | 5.33 | 4.39 | 3.66 | 2.36 | 1.13 | 25.2 | 22.5                             | 0.0                                      | 10.0                                   |  |          |
| 16800              | Right-1 | 8:31  | 34.7                    | 6594                 | 6.74                   | 5.90  | 5.28 | 4.34 | 3.52 | 2.34 | 1.12 | 25.3 | 22.5                             | 0.0                                      | 10.0                                   |  |          |
| 16800              | Right-1 | 8:31  | 34.7                    | 9831                 | 10.10                  | 8.79  | 7.86 | 6.50 | 5.30 | 3.55 | 1.70 | 24.8 | 24.4                             | 0.0                                      | 10.0                                   |  |          |
| 17200              | Left-1  | 10:04 | 37.0                    | 6594                 | 6.64                   | 5.96  | 5.48 | 4.72 | 4.01 | 2.81 | 1.40 | 21.3 | 26.1                             | 0.0                                      | 10.0                                   |  |          |
| 17200              | Left-1  | 10:04 | 37.0                    | 6605                 | 6.57                   | 5.96  | 5.46 | 4.72 | 3.99 | 2.80 | 1.41 | 21.5 | 26.2                             | 0.0                                      | 10.0                                   |  |          |
| 17200              | Left-1  | 10:04 | 37.0                    | 9646                 | 9.82                   | 8.79  | 8.10 | 7.02 | 5.97 | 4.21 | 2.09 | 20.8 | 28.0                             | 0.0                                      | 10.0                                   |  |          |
| 17400              | Right-1 | 8:32  | 35.4                    | 6693                 | 6.36                   | 5.68  | 5.20 | 4.39 | 3.70 | 2.56 | 1.22 | 24.1 | 24.8                             | 0.0                                      | 10.0                                   |  |          |
| 17400              | Right-1 | 8:32  | 35.4                    | 6682                 | 6.28                   | 5.66  | 5.18 | 4.37 | 3.68 | 2.56 | 1.23 | 24.1 | 24.9                             | 0.0                                      | 10.0                                   |  |          |
| 17400              | Right-1 | 8:32  | 35.4                    | 9744                 | 9.32                   | 8.30  | 7.61 | 6.45 | 5.44 | 3.80 | 1.82 | 23.6 | 26.6                             | 0.0                                      | 10.0                                   |  |          |
| 17800              | Right-1 | 8:33  | 35.0                    | 6693                 | 6.93                   | 6.14  | 5.52 | 4.64 | 3.82 | 2.57 | 1.23 | 23.5 | 23.8                             | 0.0                                      | 10.0                                   |  |          |
| 17800              | Right-1 | 8:33  | 35.0                    | 6594                 | 6.81                   | 6.04  | 5.45 | 4.57 | 3.77 | 2.54 | 1.22 | 23.4 | 23.8                             | 0.0                                      | 10.0                                   |  |          |
| 17800              | Right-1 | 8:33  | 35.0                    | 9744                 | 10.10                  | 8.89  | 8.04 | 6.76 | 5.60 | 3.80 | 1.84 | 23.1 | 25.6                             | 0.0                                      | 10.0                                   |  |          |
| 18400              | Left-1  | 10:03 | 37.8                    | 6649                 | 6.82                   | 5.96  | 5.40 | 4.46 | 3.71 | 2.46 | 1.20 | 24.3 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 18400              | Left-1  | 10:03 | 37.8                    | 6529                 | 6.67                   | 5.86  | 5.30 | 4.38 | 3.63 | 2.43 | 1.19 | 24.2 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 18400              | Left-1  | 10:03 | 37.8                    | 9733                 | 9.94                   | 8.69  | 7.87 | 6.60 | 5.46 | 3.71 | 1.81 | 23.7 | 25.6                             | 0.0                                      | 10.0                                   |  |          |
| 18800              | Right-1 | 8:35  | 35.9                    | 6638                 | 6.83                   | 5.90  | 5.28 | 4.36 | 3.55 | 2.33 | 1.09 | 25.4 | 22.4                             | 0.0                                      | 10.0                                   |  |          |
| 18800              | Right-1 | 8:35  | 35.9                    | 6660                 | 6.75                   | 5.86  | 5.24 | 4.34 | 3.53 | 2.31 | 1.10 | 25.9 | 22.5                             | 0.0                                      | 10.0                                   |  |          |

Test Date: Nov 3, 2005  
 Daily ESALs: 9.0  
 Total AC: 6.5 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.55  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 7

From: 0+00 (TH 59)  
 To: 307+51.55 (CSAH 8)

| Location<br>(feet) | Lane    | Time  | Pvm't.<br>Surf.<br>Temp.<br>°F | Test<br>Load<br>(lb) | Sensor Readings, (mils) |       |      |      |      |      |      |      | Effective<br>Subgrade<br>R-value | Effective<br>Granular<br>Equiv.<br>(in.) | 9-Ton<br>Overlay<br>Thickness<br>(in.) | TONN<br>Maximum<br>Axle Load<br>Capacity<br>(Tons) | Comments |
|--------------------|---------|-------|--------------------------------|----------------------|-------------------------|-------|------|------|------|------|------|------|----------------------------------|--|--|--|----------|
|                    |         |       |                                |                      | d(1)                    | d(2)  | d(3) | d(4) | d(5) | d(6) | d(7) |      |                                  |  |  |  |          |
| 18800              | Right-1 | 8:36  | 36.9                           | 9755                 | 9.97                    | 8.61  | 7.72 | 6.42 | 5.24 | 3.49 | 1.66 | 25.1 | 24.4                             | 0.0                                      | 10.0                                   |  |          |
| 19200              | Left-1  | 10:01 | 37.1                           | 6527                 | 6.78                    | 5.96  | 5.43 | 4.54 | 3.78 | 2.52 | 1.12 | 23.8 | 24.0                             | 0.0                                      | 10.0                                   |  |          |
| 19200              | Left-1  | 10:01 | 37.1                           | 6594                 | 6.66                    | 5.91  | 5.36 | 4.50 | 3.72 | 2.50 | 1.12 | 23.9 | 24.1                             | 0.0                                      | 10.0                                   |  |          |
| 19200              | Left-1  | 10:01 | 37.1                           | 9744                 | 9.90                    | 8.80  | 8.00 | 6.74 | 5.63 | 3.80 | 1.70 | 23.3 | 26.1                             | 0.0                                      | 10.0                                   |  |          |
| 19800              | Right-1 | 8:36  | 34.4                           | 6582                 | 6.74                    | 6.01  | 5.47 | 4.51 | 3.84 | 2.62 | 1.26 | 23.2 | 24.4                             | 0.0                                      | 10.0                                   |  |          |
| 19800              | Right-1 | 8:36  | 34.4                           | 6649                 | 6.69                    | 5.95  | 5.42 | 4.57 | 3.81 | 2.61 | 1.26 | 23.2 | 24.4                             | 0.0                                      | 10.0                                   |  |          |
| 19800              | Right-1 | 8:36  | 34.4                           | 9733                 | 9.88                    | 8.78  | 8.03 | 6.80 | 5.68 | 3.91 | 1.89 | 22.6 | 26.3                             | 0.0                                      | 10.0                                   |  |          |
| 20000              | Left-1  | 10:00 | 36.8                           | 6638                 | 8.02                    | 7.07  | 6.37 | 5.26 | 4.30 | 2.83 | 1.33 | 20.3 | 23.8                             | 0.0                                      | 10.0                                   |  |          |
| 20000              | Left-1  | 10:00 | 36.8                           | 6662                 | 7.85                    | 6.91  | 6.22 | 5.15 | 4.19 | 2.74 | 1.28 | 20.7 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 20000              | Left-1  | 10:00 | 36.8                           | 9635                 | 11.61                   | 10.25 | 9.21 | 7.65 | 6.26 | 4.16 | 1.93 | 20.1 | 25.6                             | 0.0                                      | 10.0                                   |  |          |
| 20800              | Right-1 | 8:38  | 34.1                           | 6649                 | 6.46                    | 5.65  | 5.05 | 4.19 | 3.39 | 2.15 | 1.04 | 27.9 | 21.7                             | 0.0                                      | 10.0                                   |  |          |
| 20800              | Right-1 | 8:38  | 34.1                           | 6682                 | 6.37                    | 5.60  | 5.01 | 4.15 | 3.37 | 2.15 | 1.03 | 28.2 | 21.8                             | 0.0                                      | 10.0                                   |  |          |
| 20800              | Right-1 | 8:38  | 34.1                           | 9788                 | 9.45                    | 8.24  | 7.39 | 6.15 | 5.00 | 3.22 | 1.55 | 27.6 | 23.6                             | 0.0                                      | 10.0                                   |  |          |
| 21400              | Right-1 | 8:39  | 35.0                           | 6627                 | 6.65                    | 5.76  | 5.14 | 4.27 | 3.50 | 2.31 | 1.11 | 25.8 | 22.5                             | 0.0                                      | 10.0                                   |  |          |
| 21400              | Right-1 | 8:39  | 35.0                           | 6605                 | 6.54                    | 5.69  | 5.08 | 4.22 | 3.47 | 2.31 | 1.10 | 25.9 | 22.7                             | 0.0                                      | 10.0                                   |  |          |
| 21400              | Right-1 | 8:39  | 35.0                           | 9722                 | 9.79                    | 8.54  | 7.64 | 6.39 | 5.25 | 3.54 | 1.69 | 24.8 | 24.7                             | 0.0                                      | 10.0                                   |  |          |
| 21400              | Left-1  | 9:59  | 36.8                           | 6649                 | 7.07                    | 6.08  | 5.43 | 4.51 | 3.59 | 2.37 | 1.10 | 24.8 | 22.4                             | 0.0                                      | 10.0                                   |  |          |
| 21400              | Left-1  | 9:59  | 36.8                           | 6640                 | 6.93                    | 5.99  | 5.35 | 4.43 | 3.55 | 2.34 | 1.10 | 24.7 | 22.4                             | 0.0                                      | 10.0                                   |  |          |
| 21400              | Left-1  | 9:59  | 36.8                           | 9722                 | 10.46                   | 8.99  | 8.04 | 6.67 | 5.39 | 3.58 | 1.69 | 24.0 | 24.3                             | 0.0                                      | 10.0                                   |  |          |
| 21800              | Right-1 | 8:40  | 36.5                           | 6638                 | 6.57                    | 5.81  | 5.27 | 4.43 | 3.62 | 2.45 | 1.18 | 24.7 | 23.8                             | 0.0                                      | 10.0                                   |  |          |
| 21800              | Right-1 | 8:40  | 36.5                           | 6649                 | 6.52                    | 5.80  | 5.25 | 4.41 | 3.61 | 2.44 | 1.17 | 24.9 | 23.8                             | 0.0                                      | 10.0                                   |  |          |
| 21800              | Right-1 | 8:40  | 36.5                           | 9722                 | 9.70                    | 8.57  | 7.81 | 6.60 | 5.44 | 3.69 | 1.77 | 24.0 | 25.7                             | 0.0                                      | 10.0                                   |  |          |
| 22400              | Left-1  | 9:58  | 37.5                           | 6649                 | 7.07                    | 6.44  | 5.99 | 5.27 | 4.59 | 3.39 | 1.85 | 17.3 | 29.0                             | 0.0                                      | 10.0                                   |  |          |
| 22400              | Left-1  | 9:58  | 37.5                           | 6604                 | 6.99                    | 6.36  | 5.92 | 5.21 | 4.55 | 3.37 | 1.86 | 17.2 | 29.0                             | 0.0                                      | 10.0                                   |  |          |
| 22400              | Left-1  | 9:58  | 37.5                           | 9678                 | 10.28                   | 9.35  | 8.72 | 7.70 | 6.72 | 5.02 | 2.73 | 16.9 | 30.8                             | 0.0                                      | 10.0                                   |  |          |
| 22800              | Right-1 | 8:41  | 34.7                           | 6639                 | 7.39                    | 6.26  | 5.61 | 4.68 | 3.88 | 2.73 | 1.44 | 21.5 | 23.8                             | 0.0                                      | 10.0                                   |  |          |
| 22800              | Right-1 | 8:41  | 34.7                           | 6638                 | 7.30                    | 6.20  | 5.56 | 4.63 | 3.84 | 2.69 | 1.43 | 21.9 | 23.7                             | 0.0                                      | 10.0                                   |  |          |
| 22800              | Right-1 | 8:41  | 34.7                           | 9667                 | 10.70                   | 9.04  | 8.13 | 6.81 | 5.70 | 4.07 | 2.15 | 21.1 | 25.8                             | 0.0                                      | 10.0                                   |  |          |
| 23200              | Left-1  | 9:56  | 37.0                           | 6616                 | 6.19                    | 5.59  | 5.17 | 4.50 | 3.89 | 2.85 | 1.53 | 21.3 | 27.3                             | 0.0                                      | 10.0                                   |  |          |
| 23200              | Left-1  | 9:56  | 37.0                           | 6594                 | 6.07                    | 5.50  | 5.09 | 4.43 | 3.85 | 2.81 | 1.51 | 21.6 | 27.4                             | 0.0                                      | 10.0                                   |  |          |
| 23200              | Left-1  | 9:56  | 37.0                           | 9689                 | 9.04                    | 8.15  | 7.55 | 6.60 | 5.74 | 4.24 | 2.27 | 20.9 | 29.3                             | 0.0                                      | 10.0                                   |  |          |
| 23800              | Right-1 | 8:43  | 35.1                           | 6649                 | 6.25                    | 5.59  | 5.12 | 4.40 | 3.69 | 2.57 | 1.29 | 23.9 | 25.0                             | 0.0                                      | 10.0                                   |  |          |
| 23800              | Right-1 | 8:43  | 35.1                           | 6594                 | 6.20                    | 5.56  | 5.07 | 4.37 | 3.67 | 2.56 | 1.29 | 23.8 | 25.1                             | 0.0                                      | 10.0                                   |  |          |
| 23800              | Right-1 | 8:43  | 35.1                           | 9722                 | 9.07                    | 8.14  | 7.45 | 6.41 | 5.39 | 3.77 | 1.89 | 23.9 | 26.8                             | 0.0                                      | 10.0                                   |  |          |
| 24400              | Left-1  | 9:55  | 36.9                           | 6594                 | 7.19                    | 6.50  | 6.00 | 5.20 | 4.40 | 3.13 | 1.52 | 18.9 | 26.9                             | 0.0                                      | 10.0                                   |  |          |
| 24400              | Left-1  | 9:55  | 36.9                           | 6551                 | 7.06                    | 6.38  | 5.88 | 5.07 | 4.30 | 3.08 | 1.51 | 19.1 | 26.9                             | 0.0                                      | 10.0                                   |  |          |
| 24400              | Left-1  | 9:55  | 36.9                           | 9624                 | 10.53                   | 9.51  | 8.77 | 7.63 | 6.49 | 4.63 | 2.28 | 18.6 | 28.7                             | 0.0                                      | 10.0                                   |  |          |
| 24800              | Right-1 | 8:44  | 35.3                           | 6660                 | 5.94                    | 5.32  | 4.85 | 4.13 | 3.49 | 2.47 | 1.25 | 25.2 | 24.9                             | 0.0                                      | 10.0                                   |  |          |
| 24800              | Right-1 | 8:44  | 35.3                           | 6638                 | 5.89                    | 5.28  | 4.81 | 4.09 | 3.46 | 2.46 | 1.24 | 25.3 | 24.9                             | 0.0                                      | 10.0                                   |  |          |
| 24800              | Right-1 | 8:44  | 35.3                           | 9755                 | 8.64                    | 7.80  | 7.12 | 6.08 | 5.19 | 3.72 | 1.86 | 24.7 | 27.0                             | 0.0                                      | 10.0                                   |  |          |
| 25200              | Left-1  | 9:54  | 36.9                           | 6682                 | 7.27                    | 6.44  | 5.93 | 5.06 | 4.22 | 2.93 | 1.37 | 20.4 | 25.6                             | 0.0                                      | 10.0                                   |  |          |
| 25200              | Left-1  | 9:54  | 36.9                           | 6594                 | 7.18                    | 6.36  | 5.85 | 4.98 | 4.16 | 2.89 | 1.36 | 20.4 | 25.6                             | 0.0                                      | 10.0                                   |  |          |
| 25200              | Left-1  | 9:54  | 36.9                           | 9722                 | 10.64                   | 9.49  | 8.72 | 7.46 | 6.26 | 4.35 | 2.07 | 20.0 | 27.4                             | 0.0                                      | 10.0                                   |  |          |
| 25800              | Right-1 | 8:46  | 35.4                           | 6671                 | 7.28                    | 6.54  | 6.05 | 5.22 | 4.44 | 3.21 | 1.69 | 18.6 | 27.0                             | 0.0                                      | 10.0                                   |  |          |
| 25800              | Right-1 | 8:46  | 35.4                           | 6649                 | 7.13                    | 6.43  | 5.93 | 5.11 | 4.35 | 3.16 | 1.67 | 18.9 | 27.0                             | 0.0                                      | 10.0                                   |  |          |
| 25800              | Right-1 | 8:46  | 35.4                           | 9667                 | 10.52                   | 9.43  | 8.71 | 7.56 | 6.47 | 4.72 | 2.47 | 18.3 | 28.9                             | 0.0                                      | 10.0                                   |  |          |
| 26382              | Left-1  | 9:52  | 36.9                           | 6638                 | 6.84                    | 6.13  | 5.69 | 4.94 | 4.23 | 3.02 | 1.50 | 19.9 | 27.0                             | 0.0                                      | 10.0                                   |  |          |
| 26382              | Left-1  | 9:52  | 36.9                           | 6660                 | 6.82                    | 6.15  | 5.70 | 4.96 | 4.23 | 3.03 | 1.52 | 19.9 | 27.1                             | 0.0                                      | 10.0                                   |  |          |
| 26382              | Left-1  | 9:52  | 36.9                           | 9667                 | 10.04                   | 9.02  | 8.36 | 7.28 | 6.26 | 4.49 | 2.24 | 19.4 | 28.8                             | 0.0                                      | 10.0                                   |  |          |
| 26800              | Right-1 | 8:47  | 35.2                           | 6605                 | 7.50                    | 6.35  | 5.74 | 4.88 | 4.11 | 2.95 | 1.58 | 19.8 | 25.0                             | 0.0                                      | 10.0                                   |  |          |
| 26800              | Right-1 | 8:47  | 35.2                           | 6638                 | 7.45                    | 6.33  | 5.73 | 4.85 | 4.08 | 2.93 | 1.57 | 20.1 | 25.0                             | 0.0                                      | 10.0                                   |  |          |
| 26800              | Right-1 | 8:47  | 35.2                           | 9700                 | 10.86                   | 9.21  | 8.36 | 7.11 | 6.03 | 4.38 | 2.33 | 19.7 | 26.9                             | 0.0                                      | 10.0                                   |  |          |
| 27200              | Left-1  | 9:51  | 36.9                           | 6638                 | 6.92                    | 6.22  | 5.74 | 4.95 | 4.19 | 2.89 | 1.42 | 20.6 | 26.2                             | 0.0                                      | 10.0                                   |  |          |
| 27200              | Left-1  | 9:51  | 36.9                           | 6583                 | 6.83                    | 6.14  | 5.66 | 4.89 | 4.13 | 2.87 | 1.42 | 20.7 | 26.2                             | 0.0                                      | 10.0                                   |  |          |
| 27200              | Left-1  | 9:51  | 36.9                           | 9700                 | 10.05                   | 9.07  | 8.35 | 7.24 | 6.14 | 4.29 | 2.15 | 20.4 | 28.0                             | 0.0                                      | 10.0                                   |  |          |
| 27800              | Right-1 | 8:48  | 34.8                           | 6605                 | 6.95                    | 6.26  | 5.77 | 4.97 | 4.23 | 3.00 | 1.46 | 19.9 | 26.4                             | 0.0                                      | 10.0                                   |  |          |
| 27800              | Right-1 | 8:48  | 34.8                           | 6638                 | 6.94                    | 6.28  | 5.79 | 5.01 | 4.26 | 3.01 | 1.46 | 20.0 | 26.5                             | 0.0                                      | 10.0                                   |  |          |
| 27800              | Right-1 | 8:48  | 34.8                           | 9777                 | 10.37                   | 9.33  | 8.62 | 7.45 | 6.37 | 4.53 | 2.22 | 19.5 | 28.3                             | 0.0                                      | 10.0                                   |  |          |

Braun Intertec Corporation - Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESALs: 9.0  
 Total AC: 6.5 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.55  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 7

From: 0+00 (TH 59)  
 To: 307+51.55 (CSAH 8)

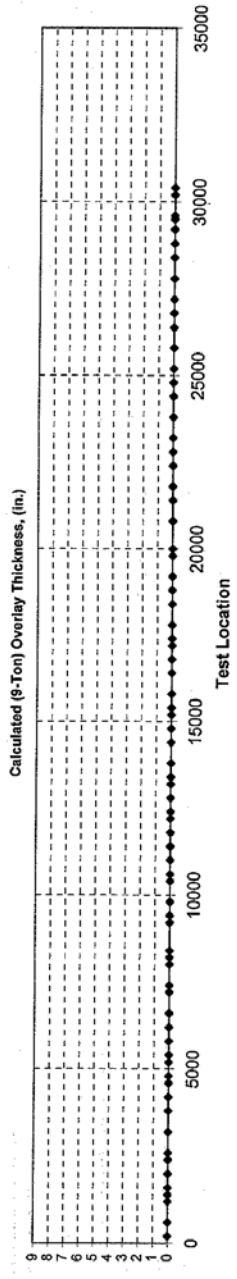
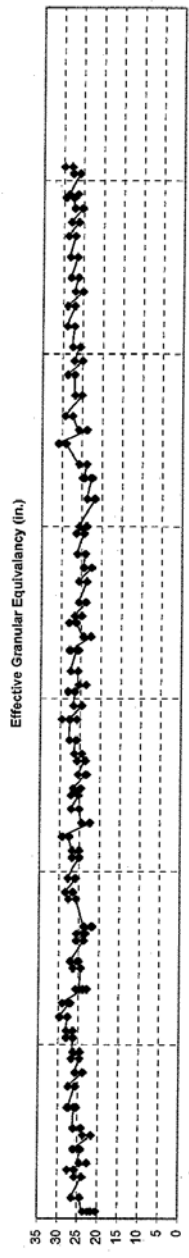
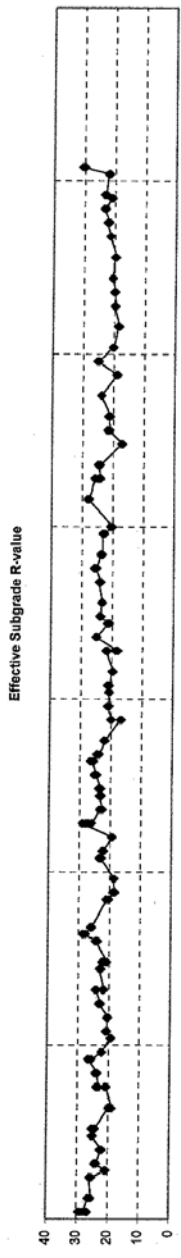
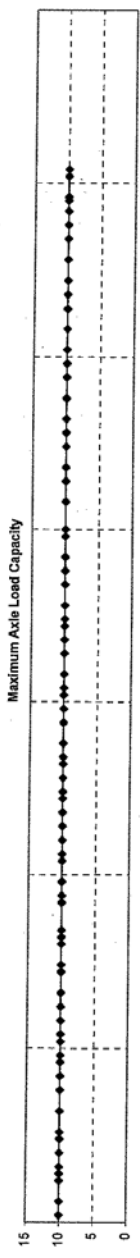
| Location (feet) |       |         | Time | PvmL Surf. Temp. °F | Test Load (lb) | Sensor Readings, (mils) |      |      |      |      |      |      | Effective Subgrade R-value | Effective Granular Equiv. (in.) | 9-Ton Overlay Thickness (in.) | TONN Maximum Axle Load Capacity (Tons) | Comments |
|-----------------|-------|---------|------|---------------------|----------------|-------------------------|------|------|------|------|------|------|----------------------------|---------------------------------|-------------------------------|--|----------|
| Left            | Right | Lane    |      |                     |                | d(1)                    | d(2) | d(3) | d(4) | d(5) | d(7) |      |                            |                                 |                               |  |          |
| 28400           |       | Left-1  | 9:50 | 36.9                | 6758           | 6.39                    | 5.74 | 5.30 | 4.99 | 3.91 | 2.90 | 1.46 | 21.4                       | 27.1                            | 0.0                           | 10.0                                   |          |
| 28400           |       | Left-1  | 9:50 | 36.9                | 6649           | 6.26                    | 5.67 | 5.22 | 4.53 | 3.85 | 2.84 | 1.45 | 21.5                       | 27.0                            | 0.0                           | 10.0                                   |          |
| 28400           |       | Left-1  | 9:50 | 36.9                | 9755           | 9.19                    | 8.26 | 7.65 | 6.65 | 5.71 | 4.19 | 2.17 | 21.4                       | 28.7                            | 0.0                           | 10.0                                   |          |
|                 | 28800 | Right-1 | 8:50 | 35.0                | 6680           | 6.22                    | 5.62 | 5.17 | 4.48 | 3.80 | 2.74 | 1.41 | 22.5                       | 26.2                            | 0.0                           | 10.0                                   |          |
|                 | 28900 | Right-1 | 8:50 | 35.0                | 6594           | 6.19                    | 5.55 | 5.13 | 4.45 | 3.76 | 2.72 | 1.41 | 22.5                       | 26.1                            | 0.0                           | 10.0                                   |          |
|                 | 28800 | Right-1 | 8:50 | 35.0                | 9744           | 9.27                    | 8.23 | 7.63 | 6.64 | 5.66 | 4.12 | 2.13 | 21.8                       | 28.0                            | 0.0                           | 10.0                                   |          |
| 29200           |       | Left-1  | 9:49 | 37.1                | 6704           | 6.42                    | 5.56 | 5.11 | 4.38 | 3.70 | 2.62 | 1.33 | 23.6                       | 25.2                            | 0.0                           | 10.0                                   |          |
| 29200           |       | Left-1  | 9:49 | 37.1                | 6726           | 6.41                    | 5.60 | 5.13 | 4.41 | 3.72 | 2.63 | 1.33 | 23.6                       | 25.3                            | 0.0                           | 10.0                                   |          |
| 29200           |       | Left-1  | 9:49 | 37.1                | 9810           | 9.44                    | 8.26 | 7.57 | 6.52 | 5.54 | 3.94 | 1.99 | 22.9                       | 27.2                            | 0.0                           | 10.0                                   |          |
|                 | 29500 | Right-1 | 8:51 | 35.6                | 6627           | 6.04                    | 5.36 | 4.94 | 4.30 | 3.74 | 2.85 | 1.69 | 21.3                       | 27.4                            | 0.0                           | 10.0                                   |          |
|                 | 29500 | Right-1 | 8:51 | 35.6                | 6649           | 6.03                    | 5.34 | 4.93 | 4.31 | 3.74 | 2.86 | 1.71 | 21.3                       | 27.5                            | 0.0                           | 10.0                                   |          |
|                 | 29500 | Right-1 | 8:51 | 35.6                | 9700           | 8.86                    | 7.87 | 7.25 | 6.37 | 5.55 | 4.26 | 2.52 | 20.8                       | 29.4                            | 0.0                           | 10.0                                   |          |
| 29600           |       | Left-1  | 9:48 | 37.0                | 6605           | 6.03                    | 5.39 | 4.94 | 4.28 | 3.67 | 2.69 | 1.44 | 22.8                       | 26.5                            | 0.0                           | 10.0                                   |          |
| 29600           |       | Left-1  | 9:48 | 37.0                | 6638           | 5.89                    | 5.28 | 4.82 | 4.18 | 3.59 | 2.64 | 1.45 | 23.5                       | 26.4                            | 0.0                           | 10.0                                   |          |
| 29600           |       | Left-1  | 9:48 | 37.0                | 9755           | 8.60                    | 7.81 | 7.14 | 6.22 | 5.37 | 3.95 | 2.17 | 22.9                       | 28.6                            | 0.0                           | 10.0                                   |          |
|                 | 30200 | Right-1 | 8:52 | 35.9                | 6693           | 6.52                    | 5.86 | 5.38 | 4.62 | 3.93 | 2.76 | 1.35 | 22.2                       | 25.9                            | 0.0                           | 10.0                                   |          |
|                 | 30200 | Right-1 | 8:52 | 35.9                | 6583           | 6.45                    | 5.80 | 5.31 | 4.58 | 3.88 | 2.73 | 1.34 | 22.1                       | 25.9                            | 0.0                           | 10.0                                   |          |
|                 | 30200 | Right-1 | 8:52 | 35.9                | 9689           | 9.56                    | 8.56 | 7.88 | 6.79 | 5.79 | 4.08 | 2.00 | 21.7                       | 27.6                            | 0.0                           | 10.0                                   |          |
|                 | 30400 | Right-1 | 8:55 | 35.9                | 6627           | 3.78                    | 3.41 | 3.18 | 2.87 | 2.65 | 2.09 | 1.28 | 30.6                       | 27.8                            | 0.0                           | 10.0                                   |          |
|                 | 30400 | Right-1 | 8:55 | 35.9                | 6583           | 3.72                    | 3.40 | 3.17 | 2.88 | 2.60 | 2.07 | 1.28 | 30.7                       | 27.9                            | 0.0                           | 10.0                                   |          |
|                 | 30400 | Right-1 | 8:55 | 35.9                | 9635           | 5.52                    | 5.04 | 4.72 | 4.28 | 3.89 | 3.10 | 1.90 | 29.7                       | 29.9                            | 0.0                           | 10.0                                   |          |



Braun Intertec Corporation • Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESALs: 9.0  
 Total AC: 6.5 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.55  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 7  
 From: 0+00 (TH 59)  
 To: 307+51.66 (CSAH 8)



Braun Intertec Corporation - Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESALS: 11.0  
 Total AC: 11.9 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.45  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 8

From: 0+00 (Polk Co Line)  
 To: 105+98.47 (TH 92)

| Left | Right | Lane    | Time | Pvm't. Surf. Temp. °F | Test Load (lb) | Sensor Readings, (mils) |      |      |      |      |      |      | Effective Subgrade R-value | Effective Granular Equiv. (in.) | 9-Ton Overlay Thickness (in.) | TONN Maximum Axle Load Capacity (Tons) | Comments                       |
|------|-------|---------|------|-----------------------|----------------|-------------------------|------|------|------|------|------|------|----------------------------|---------------------------------|-------------------------------|--|--------------------------------|
|      |       |         |      |                       |                | d(1)                    | d(2) | d(3) | d(4) | d(5) | d(6) | d(7) |                            |                                 |                               |  |                                |
|      |       |         |      |                       |                |                         |      |      |      |      |      |      |                            |                                 |                               |  | 0+00 POLK CO LINE WHERE SHOULD |
|      | 200   | Right-1 | 9:00 | 36.4                  | 6888           | 3.19                    | 2.91 | 2.79 | 2.57 | 2.35 | 2.00 | 1.38 | 33.7                       | 30.1                            | 0.0                           | 10.0                                   |                                |
|      | 200   | Right-1 | 9:00 | 36.4                  | 6802           | 3.18                    | 2.89 | 2.76 | 2.56 | 2.32 | 1.98 | 1.37 | 33.9                       | 29.9                            | 0.0                           | 10.0                                   |                                |
|      | 200   | Right-1 | 9:00 | 36.4                  | 9552           | 4.66                    | 4.25 | 4.06 | 3.75 | 3.44 | 2.89 | 2.00 | 34.1                       | 31.4                            | 0.0                           | 10.0                                   |                                |
| 800  |       | Left-1  | 9:34 | 37.0                  | 6704           | 3.70                    | 3.37 | 3.20 | 2.92 | 2.65 | 2.14 | 1.33 | 31.2                       | 29.5                            | 0.0                           | 10.0                                   |                                |
| 800  |       | Left-1  | 9:34 | 37.0                  | 6649           | 3.63                    | 3.34 | 3.18 | 2.90 | 2.63 | 2.11 | 1.31 | 31.4                       | 29.6                            | 0.0                           | 10.0                                   |                                |
| 800  |       | Left-1  | 9:34 | 37.0                  | 9766           | 5.46                    | 4.94 | 4.69 | 4.30 | 3.89 | 3.15 | 1.94 | 30.9                       | 31.1                            | 0.0                           | 10.0                                   |                                |
|      | 1200  | Right-1 | 9:02 | 35.9                  | 6737           | 3.99                    | 3.64 | 3.46 | 3.16 | 2.85 | 2.29 | 1.37 | 29.0                       | 29.9                            | 0.0                           | 10.0                                   |                                |
|      | 1200  | Right-1 | 9:02 | 35.9                  | 6737           | 3.99                    | 3.64 | 3.46 | 3.16 | 2.84 | 2.28 | 1.36 | 29.2                       | 29.7                            | 0.0                           | 10.0                                   |                                |
|      | 1200  | Right-1 | 9:02 | 35.9                  | 9799           | 5.91                    | 5.35 | 5.08 | 4.64 | 4.18 | 3.37 | 2.02 | 28.6                       | 31.3                            | 0.0                           | 10.0                                   |                                |
| 1600 |       | Left-1  | 9:33 | 36.9                  | 6726           | 3.77                    | 3.47 | 3.28 | 2.99 | 2.71 | 2.23 | 1.43 | 29.5                       | 30.3                            | 0.0                           | 10.0                                   |                                |
| 1600 |       | Left-1  | 9:33 | 36.9                  | 6682           | 3.76                    | 3.46 | 3.28 | 2.97 | 2.71 | 2.23 | 1.43 | 29.3                       | 30.3                            | 0.0                           | 10.0                                   |                                |
| 1600 |       | Left-1  | 9:33 | 36.9                  | 9733           | 5.60                    | 5.00 | 4.80 | 4.37 | 3.98 | 3.28 | 2.10 | 29.1                       | 31.6                            | 0.0                           | 10.0                                   |                                |
|      | 2200  | Right-1 | 9:03 | 36.3                  | 6769           | 3.37                    | 3.05 | 2.89 | 2.61 | 2.36 | 1.91 | 1.19 | 36.7                       | 27.9                            | 0.0                           | 10.0                                   |                                |
|      | 2200  | Right-1 | 9:03 | 36.3                  | 6748           | 3.38                    | 3.05 | 2.90 | 2.64 | 2.40 | 1.93 | 1.20 | 36.0                       | 28.2                            | 0.0                           | 10.0                                   |                                |
|      | 2200  | Right-1 | 9:03 | 36.3                  | 9897           | 5.02                    | 4.52 | 4.31 | 3.94 | 3.58 | 2.91 | 1.80 | 34.6                       | 30.3                            | 0.0                           | 10.0                                   |                                |
| 2800 |       | Left-1  | 9:31 | 36.8                  | 6627           | 2.94                    | 2.63 | 2.47 | 2.25 | 2.02 | 1.61 | 1.02 | 44.7                       | 25.8                            | 0.0                           | 10.0                                   |                                |
| 2800 |       | Left-1  | 9:31 | 36.8                  | 6583           | 2.93                    | 2.61 | 2.44 | 2.22 | 2.01 | 1.59 | 1.00 | 45.1                       | 25.6                            | 0.0                           | 10.0                                   |                                |
| 2800 |       | Left-1  | 9:31 | 36.8                  | 9744           | 4.44                    | 3.96 | 3.72 | 3.40 | 3.07 | 2.44 | 1.54 | 43.0                       | 27.8                            | 0.0                           | 10.0                                   |                                |
|      | 3200  | Right-1 | 9:04 | 35.6                  | 6680           | 3.22                    | 2.91 | 2.74 | 2.50 | 2.26 | 1.88 | 1.20 | 36.3                       | 28.2                            | 0.0                           | 10.0                                   |                                |
|      | 3200  | Right-1 | 9:04 | 35.6                  | 6671           | 3.22                    | 2.92 | 2.74 | 2.51 | 2.26 | 1.88 | 1.20 | 36.4                       | 28.2                            | 0.0                           | 10.0                                   |                                |
|      | 3200  | Right-1 | 9:04 | 35.6                  | 9711           | 4.74                    | 4.32 | 4.09 | 3.75 | 3.43 | 2.83 | 1.81 | 34.6                       | 30.6                            | 0.0                           | 10.0                                   |                                |
| 3600 |       | Left-1  | 9:30 | 37.0                  | 6748           | 3.83                    | 3.56 | 3.43 | 3.01 | 2.65 | 2.06 | 1.19 | 33.7                       | 28.0                            | 0.0                           | 10.0                                   |                                |
| 3600 |       | Left-1  | 9:30 | 37.0                  | 6737           | 3.80                    | 3.50 | 3.39 | 2.99 | 2.64 | 2.06 | 1.19 | 33.6                       | 28.1                            | 0.0                           | 10.0                                   |                                |
| 3600 |       | Left-1  | 9:30 | 37.0                  | 9799           | 5.56                    | 5.17 | 5.00 | 4.43 | 3.90 | 3.03 | 1.76 | 33.1                       | 29.8                            | 0.0                           | 10.0                                   |                                |
|      | 4200  | Right-1 | 9:05 | 35.8                  | 6660           | 4.15                    | 3.84 | 3.66 | 3.33 | 3.01 | 2.39 | 1.35 | 27.1                       | 30.4                            | 0.0                           | 10.0                                   |                                |
|      | 4200  | Right-1 | 9:05 | 35.8                  | 6605           | 4.12                    | 3.78 | 3.63 | 3.28 | 2.96 | 2.35 | 1.34 | 27.4                       | 30.1                            | 0.0                           | 10.0                                   |                                |
|      | 4200  | Right-1 | 9:05 | 35.8                  | 9733           | 6.14                    | 5.62 | 5.37 | 4.90 | 4.41 | 3.51 | 1.99 | 27.0                       | 31.7                            | 0.0                           | 10.0                                   |                                |
| 4800 |       | Left-1  | 9:28 | 36.8                  | 6682           | 2.22                    | 1.98 | 1.89 | 1.78 | 1.65 | 1.39 | 0.96 | 51.4                       | 26.1                            | 0.0                           | 10.0                                   |                                |
| 4800 |       | Left-1  | 9:28 | 36.8                  | 6496           | 2.19                    | 1.97 | 1.84 | 1.67 | 1.57 | 1.36 | 0.94 | 51.3                       | 25.8                            | 0.0                           | 10.0                                   |                                |
| 4800 |       | Left-1  | 9:28 | 36.8                  | 9547           | 3.23                    | 2.91 | 2.72 | 2.47 | 2.33 | 2.01 | 1.39 | 50.8                       | 27.6                            | 0.0                           | 10.0                                   |                                |
|      | 5200  | Right-1 | 9:08 | 36.6                  | 6627           | 4.23                    | 3.90 | 3.70 | 3.41 | 3.09 | 2.51 | 1.53 | 25.0                       | 31.4                            | 0.0                           | 10.0                                   |                                |
|      | 5200  | Right-1 | 9:08 | 36.6                  | 6562           | 4.22                    | 3.87 | 3.68 | 3.37 | 3.06 | 2.48 | 1.53 | 25.2                       | 31.2                            | 0.0                           | 10.0                                   |                                |
|      | 5200  | Right-1 | 9:08 | 36.6                  | 9556           | 6.20                    | 5.66 | 5.37 | 4.91 | 4.46 | 3.63 | 2.24 | 25.4                       | 32.5                            | 0.0                           | 10.0                                   |                                |
|      | 5600  | Left-1  | 9:27 | 37.0                  | 6605           | 2.91                    | 2.58 | 2.48 | 2.24 | 2.04 | 1.67 | 1.09 | 41.9                       | 26.9                            | 0.0                           | 10.0                                   |                                |
| 5600 |       | Left-1  | 9:27 | 37.0                  | 6496           | 2.85                    | 2.56 | 2.45 | 2.22 | 2.01 | 1.65 | 1.08 | 41.5                       | 27.1                            | 0.0                           | 10.0                                   |                                |
| 5600 |       | Left-1  | 9:27 | 37.0                  | 9492           | 4.22                    | 3.78 | 3.62 | 3.28 | 2.98 | 2.46 | 1.59 | 40.4                       | 28.9                            | 0.0                           | 10.0                                   |                                |
|      | 5700  | Right-1 | 9:10 | 36.9                  | 6529           | 5.23                    | 4.98 | 4.58 | 4.00 | 3.51 | 2.69 | 1.54 | 23.4                       | 29.4                            | 0.0                           | 10.0                                   |                                |
|      | 5700  | Right-1 | 9:10 | 36.9                  | 6540           | 5.24                    | 4.97 | 4.58 | 3.99 | 3.50 | 2.68 | 1.54 | 23.6                       | 29.2                            | 0.0                           | 10.0                                   |                                |
|      | 5700  | Right-1 | 9:10 | 36.9                  | 9656           | 7.73                    | 7.28 | 6.72 | 5.90 | 5.18 | 3.99 | 2.26 | 23.3                       | 30.9                            | 0.0                           | 10.0                                   |                                |
| 6200 |       | Right-1 | 9:11 | 35.9                  | 6627           | 3.23                    | 2.91 | 2.78 | 2.52 | 2.28 | 1.86 | 1.14 | 36.7                       | 28.0                            | 0.0                           | 10.0                                   |                                |
| 6200 |       | Right-1 | 9:11 | 35.9                  | 6594           | 3.21                    | 2.92 | 2.78 | 2.52 | 2.30 | 1.87 | 1.15 | 36.1                       | 28.3                            | 0.0                           | 10.0                                   |                                |
| 6200 |       | Right-1 | 9:11 | 35.9                  | 9766           | 4.84                    | 4.36 | 4.15 | 3.81 | 3.45 | 2.83 | 1.72 | 35.1                       | 30.2                            | 0.0                           | 10.0                                   |                                |
| 6800 |       | Right-1 | 9:12 | 36.1                  | 6671           | 3.62                    | 3.24 | 3.06 | 2.80 | 2.53 | 2.04 | 1.22 | 33.2                       | 28.5                            | 0.0                           | 10.0                                   |                                |
| 6800 |       | Right-1 | 9:12 | 36.1                  | 6593           | 3.61                    | 3.27 | 3.07 | 2.80 | 2.53 | 2.04 | 1.22 | 33.4                       | 28.6                            | 0.0                           | 10.0                                   |                                |
| 6800 |       | Right-1 | 9:12 | 36.1                  | 9842           | 5.37                    | 4.83 | 4.57 | 4.17 | 3.78 | 3.05 | 1.83 | 32.6                       | 30.4                            | 0.0                           | 10.0                                   |                                |
| 6800 |       | Left-1  | 9:25 | 36.4                  | 6693           | 4.26                    | 4.12 | 3.85 | 3.39 | 2.98 | 2.31 | 1.29 | 28.9                       | 29.1                            | 0.0                           | 10.0                                   |                                |
| 6800 |       | Left-1  | 9:25 | 36.4                  | 6571           | 4.22                    | 4.07 | 3.81 | 3.36 | 2.95 | 2.29 | 1.26 | 29.1                       | 29.0                            | 0.0                           | 10.0                                   |                                |
| 6800 |       | Left-1  | 9:25 | 36.4                  | 9755           | 6.24                    | 6.05 | 5.65 | 4.99 | 4.38 | 3.40 | 1.91 | 28.5                       | 30.7                            | 0.0                           | 10.0                                   |                                |
|      | 7200  | Right-1 | 9:13 | 36.5                  | 6660           | 3.70                    | 3.37 | 3.20 | 2.90 | 2.60 | 2.04 | 1.13 | 33.4                       | 28.3                            | 0.0                           | 10.0                                   |                                |
|      | 7200  | Right-1 | 9:13 | 36.5                  | 6582           | 3.72                    | 3.41 | 3.22 | 2.93 | 2.62 | 2.04 | 1.14 | 33.6                       | 28.2                            | 0.0                           | 10.0                                   |                                |
|      | 7200  | Right-1 | 9:13 | 36.5                  | 9799           | 5.63                    | 5.05 | 4.79 | 4.35 | 3.89 | 3.07 | 1.73 | 32.6                       | 29.8                            | 0.0                           | 10.0                                   |                                |
| 7800 |       | Left-1  | 9:24 | 36.9                  | 6715           | 4.45                    | 4.11 | 3.89 | 3.52 | 3.18 | 2.50 | 1.44 | 26.1                       | 30.4                            | 0.0                           | 10.0                                   |                                |
| 7800 |       | Left-1  | 9:24 | 36.9                  | 6627           | 4.40                    | 4.07 | 3.85 | 3.50 | 3.13 | 2.46 | 1.43 | 26.2                       | 30.2                            | 0.0                           | 10.0                                   |                                |
| 7800 |       | Left-1  | 9:24 | 36.9                  | 9766           | 6.60                    | 6.06 | 5.74 | 5.22 | 4.69 | 3.71 | 2.15 | 25.4                       | 31.9                            | 0.0                           | 10.0                                   |                                |
|      | 8200  | Right-1 | 9:14 | 36.7                  | 6649           | 4.61                    | 4.18 | 3.93 | 3.52 | 3.10 | 2.31 | 1.14 | 29.1                       | 27.9                            | 0.0                           | 10.0                                   |                                |
|      | 8200  | Right-1 | 9:14 | 36.7                  | 6649           | 4.59                    | 4.16 | 3.90 | 3.50 | 3.09 | 2.30 | 1.14 | 29.2                       | 27.9                            | 0.0                           | 10.0                                   |                                |
|      | 8200  | Right-1 | 9:14 | 36.7                  | 9700           | 6.88                    | 6.16 | 5.83 | 5.21 | 4.58 | 3.43 | 1.69 | 28.4                       | 29.4                            | 0.0                           | 10.0                                   |                                |

Braun Intertec Corporation - Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESALs: 11.0  
 Total AC: 11.9 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.45  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 8

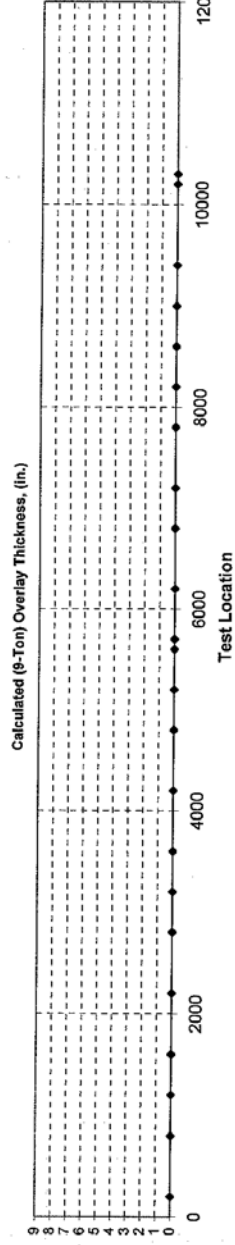
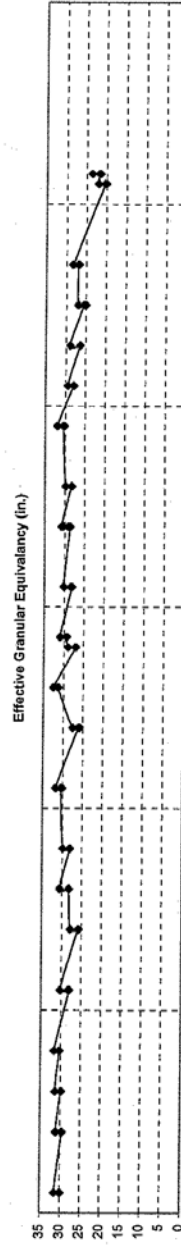
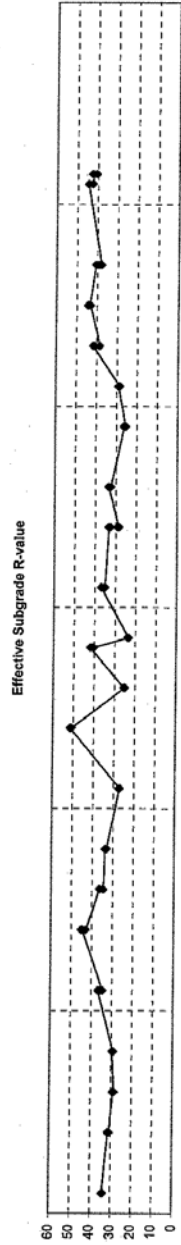
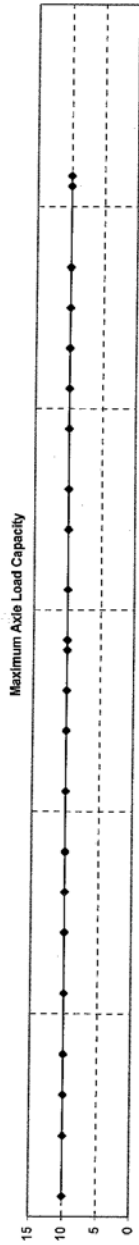
From: 0+00 (Polk Co Line)  
 To: 105+98.47 (TH 92)

| Location (feet) |       | Lane    | Time | Pvm'L Surf. Temp. °F | Test Load (lb) | Sensor Readings, (mil) |      |      |      |      |      |      | Effective Subgrade R-value | Effective Granular Equiv. (in.) | 9-Ton Overlay Thickness (in.) | TONN Maximum Axle Load Capacity (Tons) | Comments |
|-----------------|-------|---------|------|----------------------|----------------|------------------------|------|------|------|------|------|------|----------------------------|---------------------------------|-------------------------------|--|----------|
| Left            | Right |         |      |                      |                | d(1)                   | d(2) | d(3) | d(4) | d(5) | d(6) | d(7) |                            |                                 |                               |  |          |
| 8600            |       | Left-1  | 9:22 | 36.9                 | 6726           | 3.19                   | 2.83 | 2.67 | 2.43 | 2.18 | 1.73 | 1.12 | 41.7                       | 26.4                            | 0.0                           | 10.0                                   |          |
| 8600            |       | Left-1  | 9:22 | 36.9                 | 6671           | 3.19                   | 2.83 | 2.66 | 2.41 | 2.13 | 1.73 | 1.12 | 41.3                       | 26.3                            | 0.0                           | 10.0                                   |          |
| 8600            |       | Left-1  | 9:22 | 36.9                 | 9810           | 4.78                   | 4.29 | 4.04 | 3.68 | 3.31 | 2.67 | 1.74 | 38.6                       | 28.9                            | 0.0                           | 10.0                                   |          |
| 9000            |       | Left-1  | 9:21 | 37.0                 | 6593           | 3.22                   | 2.81 | 2.65 | 2.38 | 2.12 | 1.68 | 1.03 | 43.3                       | 25.5                            | 0.0                           | 10.0                                   |          |
| 9000            |       | Left-1  | 9:21 | 37.0                 | 6593           | 3.22                   | 2.81 | 2.63 | 2.39 | 2.09 | 1.65 | 1.07 | 44.5                       | 25.0                            | 0.0                           | 10.0                                   |          |
| 9000            |       | Left-1  | 9:21 | 37.0                 | 9766           | 4.68                   | 4.11 | 3.85 | 3.47 | 3.09 | 2.44 | 1.50 | 43.6                       | 27.0                            | 0.0                           | 10.0                                   |          |
|                 | 9400  | Right-1 | 9:16 | 36.6                 | 6824           | 3.18                   | 2.86 | 2.70 | 2.45 | 2.22 | 1.78 | 1.09 | 40.6                       | 27.0                            | 0.0                           | 10.0                                   |          |
|                 | 9400  | Right-1 | 9:16 | 36.6                 | 6791           | 3.18                   | 2.84 | 2.68 | 2.44 | 2.20 | 1.77 | 1.08 | 40.7                       | 26.9                            | 0.0                           | 10.0                                   |          |
|                 | 9400  | Right-1 | 9:16 | 36.6                 | 9897           | 4.72                   | 4.20 | 3.97 | 3.60 | 3.26 | 2.61 | 1.59 | 40.2                       | 28.4                            | 0.0                           | 10.0                                   |          |
|                 | 9400  | Left-1  | 9:20 | 36.9                 | 6748           | 3.45                   | 3.11 | 2.98 | 2.70 | 2.37 | 1.85 | 1.09 | 38.6                       | 26.9                            | 0.0                           | 10.0                                   |          |
|                 | 9400  | Left-1  | 9:20 | 36.9                 | 6737           | 3.43                   | 3.09 | 2.94 | 2.70 | 2.36 | 1.83 | 1.08 | 39.1                       | 26.7                            | 0.0                           | 10.0                                   |          |
|                 | 9400  | Left-1  | 9:20 | 36.9                 | 9810           | 5.24                   | 4.67 | 4.40 | 4.00 | 3.54 | 2.74 | 1.57 | 37.9                       | 28.2                            | 0.0                           | 10.0                                   |          |
|                 | 10200 | Right-1 | 9:17 | 36.2                 | 6649           | 4.58                   | 3.95 | 3.51 | 2.82 | 2.35 | 1.54 | 0.66 | 44.6                       | 20.3                            | 0.0                           | 10.0                                   |          |
|                 | 10200 | Right-1 | 9:17 | 36.2                 | 6452           | 4.46                   | 3.78 | 3.36 | 2.69 | 2.26 | 1.49 | 0.65 | 44.7                       | 20.1                            | 0.0                           | 10.0                                   |          |
|                 | 10200 | Right-1 | 9:17 | 36.2                 | 9460           | 6.74                   | 5.76 | 5.15 | 4.17 | 3.45 | 2.28 | 1.00 | 42.6                       | 22.0                            | 0.0                           | 10.0                                   |          |
| 10300           |       | Left-1  | 9:19 | 36.4                 | 6616           | 4.41                   | 3.87 | 3.51 | 2.98 | 2.41 | 1.65 | 0.83 | 42.3                       | 21.7                            | 0.0                           | 10.0                                   |          |
| 10300           |       | Left-1  | 9:19 | 36.4                 | 6551           | 4.35                   | 3.81 | 3.45 | 2.93 | 2.37 | 1.62 | 0.82 | 42.7                       | 21.6                            | 0.0                           | 10.0                                   |          |
| 10300           |       | Left-1  | 9:19 | 36.4                 | 9678           | 6.61                   | 5.76 | 5.22 | 4.43 | 3.63 | 2.50 | 1.23 | 40.6                       | 23.6                            | 0.0                           | 10.0                                   |          |

Braun Intertec Corporation • Project No. BL-05-05134

Test Date: Nov 3, 2005  
 Daily ESALs: 11.0  
 Total AC: 11.9 in.  
 Surface Condition Rating: 5.0  
 Seasonal Correction Factor: 1.45  
 Prev. Day's Avg. Air Temp.: 47 °F

Client: Red Lake County Highway  
 Roadway: CSAH 8  
 From: 0+00 (Polk Co Line)  
 To: 105+98.47 (TH 92)



**Appendix C**  
**Index to Video Documentation Files contained on CD**



| <b>Index to Electronic Files on CD</b> |  |                  |  |
|--|--|------------------|--|
| <b>Contents</b>                        | <b>File / Folder</b>                             | <b>File Type</b> | <b>Notes / Comments</b>                        |
| Executive Summary                      | Executive Summary-Final                          | MS Word          |  |
| Tech Data Page                         | TechDoc_EPub                                     | MS Word          |  |
| Full Report Body                       | EPubReport_Paving_Fabrics                        | MS Word          |  |
| Full Report Body                       | Editor to convert from MS Word file              | ADOBE PDF        |  |
| Mini- Electronic Presentation          | 29 August Mini-File Evaluation of Paving Fabrics | MS Powerpoint    |  |
| Tabulation of Cracking Video           | Video Tabulation of Cracking                     | MS Powerpoint    | Videos imbedded in slides                      |
| Test Segment Pre-Pave Videos           | CSAH # 7 & CSAH #8 Video Folders                 | .MOV             | Labeled by test segment, embedded in PPT Files |
| Test Segment Pre-Pave Stills           | CSAH 8 Stills (Folder)                           | .JPG             |  |
| Test Segment Post-Pave Videos          | CSAH # 7 & CSAH #8 Video Folders                 | .MOV             | Labeled by test segment, embedded in PPT Files |
| CSAH # 10 Video Clips                  | CSAH #10 New Bit 2005                            | .MOV             |  |
| Core Sample Pictures                   | Bit Cores 6_06                                   | JPG              |  |
| FWD Report Extracts                    | BRAUN FWD Report Results File & BRAUN Data File  | ADOBE PDF        |  |

**Appendix D**  
**Presentation Files**

# Evaluation of Paving Fabrics for Isolation of Bituminous Cracking

RLC Hwy Dept      MN/DOT  
LRRB      SALT      UM CTS

1/4/2008

@file

1

## Why Propose a Test Project?

### ■ **BACKGROUND**

- Bituminous pavements require major seasonal maintenance for both thermal and distress crack repairs.
- Reconstruction, structural upgrades or maintenance overlays generally include intensive and expensive milling or reclaim operations to reduce/retard the effects of existing cracking or crack sealants.
- Traffic levels and axle weights on the Trunk Highway and County State Aid Highway systems continue to increase.
- New State and State Aid studies propose to upgrade thousands of Minnesota CSAH miles from 7-ton to 9-ton to 10-ton routes.
- Less expensive alternatives to isolate existing problems and retain strength and usability of existing roadways are needed.

1/4/2008

@file

2

## Evaluation of Paving Fabrics for Isolation of Bituminous Cracking

- **OBJECTIVE**
- *The objective of this project is to install, provide photographic and narrative results and recommendations on the use of paving fabrics for reflective cracking isolation and pavement strength enhancement.*
  
- **Deliverable(s):** A publishable hard copy with photos, a Summary Electronic Slide Presentation and a more detailed Electronic Slide Presentation
  
- **Duration:** 16 Months from Contract Execution= Aug 31, 2007

1/4/2008

@file

3

### Paving fabrics for reflective cracking isolation and pavement strength enhancement

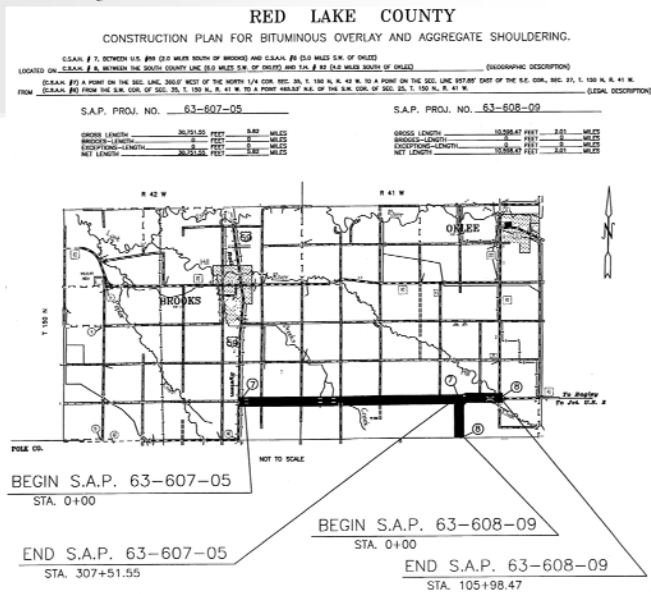
- ? : Does Fabric Isolate Cracking as manufacturers claim?
- ? : Does fabric add to structural strength?
- ? : Does fabric retard thermal cracking in frigid temperature?
  
- **Pre-Pave Data:**
  - Visual, Video & FWD
- **Post-Pave Data:** Paving + 2 Years for Final Report
  - Visual, Video, FWD, Cores, Summary Report, Documented Data

1/4/2008

@file

4

## 2005 Test Project:

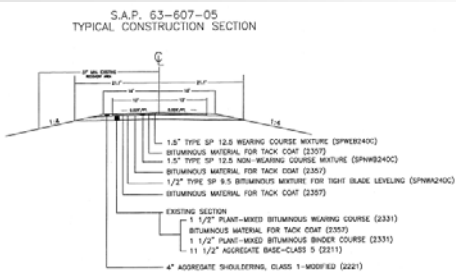


1/4/2008

@file

5

## Pre-pave conditions CSAH #7



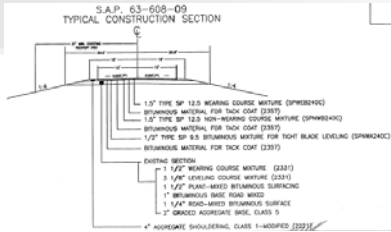
- Insert 10 second bytes of test sections

1/4/2008

@file

6

# Pre-pave conditions: CSAH #8



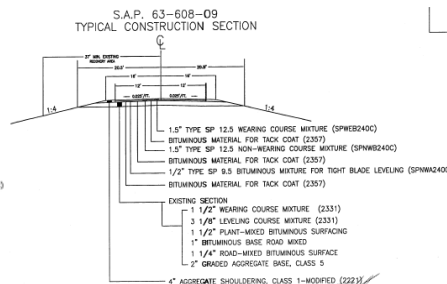
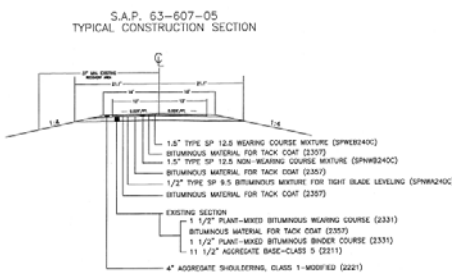
- Insert 10 second bytes of test sections

1/4/2008

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7

# Test segments & variations



- CSAH # 7: 11 1/2" Base & 3" Existing Bit
- CSAH # 8: 2" Base, 8" Layered Bit

1/4/2008

@file

8

# Additive for Testing Fabric

| ADDITIVE BID ITEM #1<br>SEE SPECIAL PROVISIONS |            |           |          |     |     |          |
|--|------------|-----------|----------|-----|-----|----------|
| TEST OPTION                                    | C.S.A.H. # | BEGN STA. | END STA. | LT. | RT. | SQ. YDS. |
| 1  | #8         | 0+00      | 3+00     | X   |     | 100      |
| 2  | #7         | 0+00      | 307+51   | X   |     | 9,450    |
| 2  | #8         | 0+00      | 105+98   | X   |     | 3,622    |
| 6  | #7         | 0+25      | 3+25     | X   | X   | 800      |
| 5  | #7         | 38+00     | 38+00    | X   | X   | 800      |
| 6  | #7         | 45+00     | 51+00    | X   | X   | 1,600    |
| 4  | #7         | 58+00     | 58+00    | X   | X   | 400      |
| 6  | #7         | 64+00     | 67+00    | X   | X   | 800      |
| 6  | #7         | 73+00     | 76+00    | X   | X   | 800      |
| 4  | #7         | 104+00    | 107+00   | X   |     | 400      |
| 3  | #7         | 126+00    | 129+00   | X   |     | 400      |
| 6  | #7         | 213+00    | 216+00   | X   | X   | 800      |
| 6  | #7         | 295+00    | 298+00   | X   | X   | 800      |
| 6  | #8         | 67+00     | 70+00    | X   | X   | 800      |
| 6  | #8         | 92+00     | 95+00    | X   | X   | 800      |
| TOTAL PAVING FABRIC                            |            |           |          |     |     | 22,372   |

S.A.P. 63-608-09  
TYPICAL CONSTRUCTION SECTION  
G.

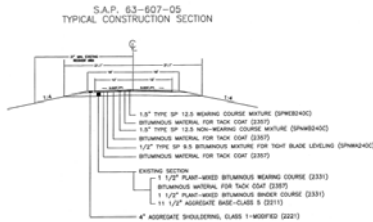
| ADDITIVE BID ITEM #1<br>SEE SPECIAL PROVISIONS |  |
|--|--|
| TEST OPTIONS - PAVING FABRIC DETAILS           |  |
| (1)  | 3' CENTERLINE STRIP OF FABRIC PLACED LONGITUDINALLY<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR) |
| (2)  | 3' CENTERLINE STRIP OF FABRIC PLACED LONGITUDINALLY<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)     |
| (3)  | FABRIC PLACED ON ONE 12' LANE<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR)                       |
| (4)  | FABRIC PLACED ON ONE 12' LANE<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)                           |
| (5)  | FABRIC PLACED FULL WIDTH 24' WITH 6" OVERLAP<br>FABRIC PLACED ON EXISTING BITUMINOUS<br>(FABRIC, 1/2" BLADE LAID, 1 1/2" NON-WEAR, 1 1/2" WEAR)        |
| (6)  | FABRIC PLACED FULL WIDTH 24' WITH 6" OVERLAP<br>FABRIC PLACED ON 1/2" BLADE LAID<br>(1/2" BLADE LAID, FABRIC, 1 1/2" NON-WEAR, 1 1/2" WEAR)            |

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## CSAH # 7: 11 1/2" Base & 3" Existing Bit



| ADDITIVE BID ITEM #1<br>SEE SPECIAL PROVISIONS |            |           |          |     |     |          |
|--|------------|-----------|----------|-----|-----|----------|
| TEST OPTION                                    | C.S.A.H. # | BEGN STA. | END STA. | LT. | RT. | SQ. YDS. |
| 1  | #8         | 0+00      | 3+00     | X   |     | 100      |
| 2  | #7         | 0+00      | 307+51   | X   |     | 9,450    |
| 2  | #8         | 0+00      | 105+98   | X   |     | 3,622    |
| 6  | #7         | 0+25      | 3+25     | X   | X   | 800      |
| 5  | #7         | 38+00     | 38+00    | X   | X   | 800      |
| 6  | #7         | 45+00     | 51+00    | X   | X   | 1,600    |
| 4  | #7         | 58+00     | 58+00    | X   | X   | 400      |
| 6  | #7         | 64+00     | 67+00    | X   | X   | 800      |
| 6  | #7         | 73+00     | 76+00    | X   | X   | 800      |
| 4  | #7         | 104+00    | 107+00   | X   |     | 400      |
| 3  | #7         | 126+00    | 129+00   | X   |     | 400      |
| 6  | #7         | 213+00    | 216+00   | X   | X   | 800      |
| 6  | #7         | 295+00    | 298+00   | X   | X   | 800      |
| 6  | #8         | 67+00     | 70+00    | X   | X   | 800      |
| 6  | #8         | 92+00     | 95+00    | X   | X   | 800      |
| TOTAL PAVING FABRIC                            |            |           |          |     |     | 22,372   |



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## CSAH # 7: 11 1/2" Base & 3" Existing Bit

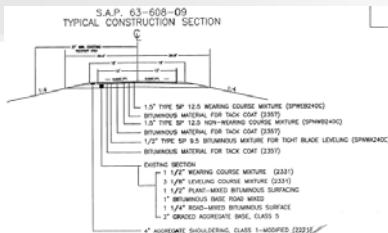


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## CSAH # 8: 2" Base, 8" Layered Bit



ADDITIVE BID ITEM #1  
SEE SPECIAL PROVISIONS

| LINE                | QTY | CSAH   | DESC   | UNIT | IN | FT | YD | WT     |
|---------------------|-----|--------|--------|------|----|----|----|--------|
| 1                   | #1  | 0+00   | 3+00   | X    |    |    |    | 100    |
| 2                   | #2  | 0+50   | 20+81  | X    |    |    |    | 9,450  |
| 3                   | #3  | 0+50   | 10+00  | X    |    |    |    | 8,000  |
| 4                   | #4  | 0+20   | 1+120  | X    |    |    |    | 800    |
| 5                   | #5  | 16+50  | 28+00  | X    |    |    |    | 800    |
| 6                   | #6  | 43+00  | 51+00  | X    |    |    |    | 1,000  |
| 7                   | #7  | 50+00  | 58+00  | X    |    |    |    | 400    |
| 8                   | #8  | 64+00  | 87+00  | X    |    |    |    | 800    |
| 9                   | #9  | 73+00  | 78+00  | X    |    |    |    | 800    |
| 10                  | #10 | 104+00 | 107+00 | X    |    |    |    | 400    |
| 11                  | #11 | 113+00 | 118+00 | X    |    |    |    | 800    |
| 12                  | #12 | 208+00 | 208+00 | X    |    |    |    | 800    |
| 13                  | #13 | 87+00  | 125+00 | X    |    |    |    | 800    |
| 14                  | #14 | 92+00  | 95+00  | X    |    |    |    | 800    |
| TOTAL PAVING FABRIC |     |        |        |      |    |    |    | 22,520 |



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## CSAH # 8: 2" Base, 8" Layered Bit



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### **Test Project Additive Bid Item:**

Fifteen 300 ft Fabric Test & 600 ft Non-Fabric Control Sections

- 300' w/o Fabric
- **300' w/ Test Fabric**
  - 300' w/o Fabric
- **Fabric Placement Tests:**
  - **Single Lane**
  - **Dual Lane**
  - **Centerline Only**
- **Fabric Sequences**
  - **Fabric,**
    - ½" Blade Laid,
      - NW Bit, WE Bit
  - ½" Blade Laid,
    - **Fabric,**
      - NW Bit, WE Bit

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# Fabric for Test Sections

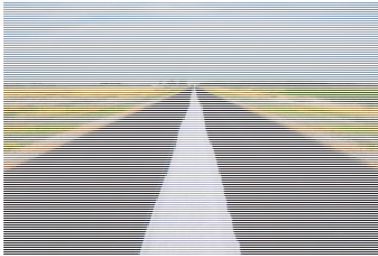


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# 3' Centerline Fabric & Paver



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 0-3+25



- Post-Pave +2 Years Pic's →
- 0-3+25
- Fabric Both Lanes



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 36-39



- Post-Pave +2 Years Pic's →
- 36-39
- Fabric Both Lanes



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 45-51



- Post-Pave +2 Years Pic's →

- 45-51
- Fabric Both Lanes



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 56-59



- Post-Pave +2 Years Pic's →

- 56-59
- Fabric Right Lane



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 64-67
  
- Post-Pave +2 Years Pic's →
- 64-67
- Fabric Both Lanes



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 73-76
  
- Post-Pave +2 Years Pic's →
- 73-76
- Fabric Both Lanes



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 104-107



- Post-Pave +2 Years Pic's →
- 104-107
- Fabric Left Lane



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 126-129



- Post-Pave +2 Years Pic's →
- 126-129
- Fabric Left Lane



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 213-216



- Post-Pave +2 Years Pic's →
- 213-216
- Fabric Both Lanes



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## CSAH #7: Traditional Base & Bit

- Pre-Pave Pic's →
- 295-298



- Post-Pave +2 Years Pic's →
- 295-298
- Fabric Both Lanes

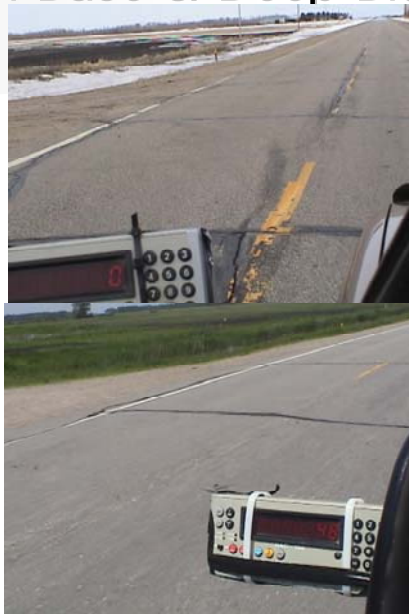


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## CSAH #8: Thin Base & Deep Bit

- Pre-Pave Pic's →
- 0-300
  
- Post-Pave +2 Years Pic's →
- 0-300
- 3' Centerline Fabric



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## CSAH #8: Thin Base & Deep Bit

- Pre-Pave Pic's →
- 67-70
  
- Post-Pave +2 Years Pic's →
- 67-70
- Fabric Both Lanes



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### CSAH #8: Thin Base & Deep Bit

- Pre-Pave Pic's →



- Post-Pave +2 Years Pic's →



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### CSAH #8: Thin Base & Deep Bit

- Pre-Pave Pic's →
- 92-95



- Post-Pave +2 Years Pic's →
- 92-95
- Fabric Both Lanes



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## Evaluation of Paving Fabrics for Isolation of Bituminous Cracking

### Conclusions:

1. Spun Glass Paving Fabric does not add structural strength when applied between Bituminous Courses (FWD Comparisons)
2. Spun Glass Paving Fabric does not retard early thermal cracking
3. Spun Glass Paving Fabric does not retard early centerline cracking at paver joints
4. Reflective distress cracking did not reappear within the first two years of paving regardless of fabric presence between existing and overlay bituminous
5. Paving fabric can be installed over existing or over fresh blade laid leveling course
6. Paving fabric can isolate heavy crack sealant from new overlay bituminous at less expense than mill and replace removed bituminous
7. Blade Laid Leveling Course mitigates heavy crack sealant effects on main courses
8. Comparable Blade Laid vs. Paving Fabric Costs vs. Mill & Replace are;
  1. ½ " Blade Laid Leveling = \$ .77 / SY (@ \$ 28. / Ton Bit)
  2. Paving Fabric Costs = \$ 2.50 / SY ( Test Section Prices )
  3. Mill 2" Depth = \$ .60 / SY Plus Replace 2" Bit = \$ 2.83 /SY for Sum of \$ 3.43 / SY (Bit \$25.75/Ton)

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## Evaluation of Paving Fabrics for Isolation of Bituminous Cracking

### Recommendations:

1. Evaluation of fabric effects should be continued here for results as reflective cracking develops in future years
2. Similar evaluation of paving fabric in less severe winter conditions should be researched
3. Until better data on fabrics is demonstrated, blade laid & overlay would be this researcher's choice for both maintenance and structural overlays

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# Recommendations

- Continue monitoring test segment performance on an annual basis for differential on crack development, specifically in frigid conditions
- Conduct similar testing and analysis of paving fabric performance in less severe winter conditions and higher volume roadways

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- MN/DOT
- SALT
- LRRB
- 
- UM CTS
- 
- RLC Hwy Dept



## Credits



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# Documentation

- Contract - WO# 88498 - 1     ARTS # 2006-028R  
TITLE: INV 838: Paving Fabrics for Isolating Existing and Overlay Bituminous Pavement  
TASK(S) Pending Approval:
- P.I. = Courtney Kleven    218/253-2697    [ckleven@aol.com](mailto:ckleven@aol.com)  
T.L. = Roger Olson    651/366-5517    [roger.olson@dot.state.mn.us](mailto:roger.olson@dot.state.mn.us)  
A.L. = Dr. Alan Rindels    651/366-3779    [alan.rindels@dot.state.mn.us](mailto:alan.rindels@dot.state.mn.us)
- Alan Rindels, PE PhD  
Program Development Engineer  
Office of Investment Management  
Research Services Ph. 651-366-3779  
Cell 612-987-7455

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# References

- Roger, are there tech references you'd like to have documented here?
  - Jan 1999 MN LRRB Geosynthetics Use in Streets & Highways?
  - MN/DOT Tech library research search?
  - MN/DOT 2350 / 2360 Bit Spec?
  
  - List of authorized materials for paving fabric use in MN???
  - SALT website for scanned project plans on the paving project?

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# Questions & Comments

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## Q & A ???

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