APPENDIX A – DYNAMIC MODULUS MASTER CURVE DATA
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**E* (PSI) vs Temperature (F) Frequency (Hz)**

- Voids (%): 6.1, 8.1, 3.5
- Vbeff (%): 11.54, 12.81, 14.14
### MEDOT E* Test Results

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Air Voids (%) --> 3.5 4.7 4.4 5.0 4.1

Vbeff (%) --> 11.7 17.1 12.6 12.6 14.35
### MEDOT E* Test Results

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 Parks: Air Voids (%) --> 6.7  Vbeff (%) --> 11.76

### MEDOT VTS-Shift E* Results

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## RIDOT E* Test Results

### LC-UC Test Results

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- **E* (PSI)**
- **Temperature (F)**
- **Frequency (Hz)**
- **Vbeff (%)**
APPENDIX B – QRSS AND SPT INPUT FILES
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<th>As Built Distress (in)</th>
<th>Design Service Life (Yrs)</th>
<th>Predicted Service Life (Yrs)</th>
<th>PLD Factor</th>
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SURFACE RUTTING
DelDOT C/160 HMA+ RAP

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**SURFACE RUTTING**

**FHWA D1083**

**SURFACE RUTTING**

**MEOOT Township D**
### SURFACE RUTTING

**FHWA MD0359**

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### SURFACE RUTTING

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Binder Rutting
FHWA DE0883

Binder Rutting
MEDOT Township D

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Binder Rutting
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**BINDER RUTTING**

**RIDOT Dunn's Corner HMA**

| QRSS - (standard Binder values) | 1 | 779.274 | 1,021.54 | 0.031 | 0.027 | 24.7 | 30.447 | 5.747 | 109.37 | 0.03 | 0.03 |
| | 2 | 779.274 | 930.435 | 0.031 | 0.029 | 24.7 | 28.176 | 3.476 | 103.69 | 0.03 | 0.03 |
| | 3 | 779.274 | 915.737 | 0.031 | 0.029 | 24.7 | 28.094 | 3.394 | 103.49 | 0.03 | 0.03 |
| | 4 | 779.274 | 1,031.67 | 0.031 | 0.027 | 24.7 | 30.883 | 6.183 | 110.00 | 0.03 | 0.03 |
| | 5 | 779.274 | 1,021.43 | 0.031 | 0.026 | 24.7 | 31.54 | 7.84 | 110.00 | 0.03 | 0.03 |
| QRSS - (experimental Binder A&VTS) | 1 | 798.974 | 1,038.19 | 0.031 | 0.026 | 24.58 | 30.303 | 5.723 | 109.31 | 0.03 | 0.03 |
| | 2 | 798.974 | 943.734 | 0.031 | 0.028 | 24.58 | 28.042 | 3.462 | 103.65 | 0.03 | 0.03 |
| | 3 | 798.974 | 938.679 | 0.031 | 0.028 | 24.58 | 27.859 | 3.379 | 103.49 | 0.03 | 0.03 |
| | 4 | 798.974 | 1,057.74 | 0.031 | 0.026 | 24.58 | 30.735 | 6.155 | 110.00 | 0.03 | 0.03 |
| | 5 | 798.974 | 1,129.24 | 0.031 | 0.025 | 24.58 | 32.384 | 7.804 | 110.00 | 0.03 | 0.03 |
| SPT - LC-UIC E* | 1 | 191.43 | 846.76 | 0.07 | 0.07 | 19.88 | 19.88 | 0.07 | 110.00 | 0.07 | 0.07 |
| | 2 | 191.43 | 728.06 | 0.07 | 0.03 | 19.88 | 19.88 | 0.07 | 110.00 | 0.07 | 0.07 |
| | 3 | 191.43 | 678.13 | 0.07 | 0.03 | 19.88 | 19.88 | 0.07 | 110.00 | 0.07 | 0.07 |
| | 4 | 191.43 | 970.42 | 0.07 | 0.03 | 19.88 | 19.88 | 0.07 | 110.00 | 0.07 | 0.07 |
| | 5 | 191.43 | 942.79 | 0.07 | 0.03 | 19.88 | 19.88 | 0.07 | 110.00 | 0.07 | 0.07 |
## BASE RUTTING
### MDEOT Township D

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### Fatigue Cracking

**DelDOT C/160 HMA+RAP**

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### Fatigue Cracking

**DelDOT SMA+RAP**

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<th>In-Situ E* (ksi)</th>
<th>Design Distress (%)</th>
<th>As Built Distress (%)</th>
<th>Design Service Life (Yrs)</th>
<th>Predicted Service Life (Yrs)</th>
<th>PLD</th>
<th>Pay Factor</th>
<th>Design Fatigue Cracking (%)</th>
<th>As-Built Fatigue Cracking (%)</th>
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<tr>
<td>QRSS</td>
<td>1</td>
<td>1,128.56</td>
<td>558.00</td>
<td>0.587921682</td>
<td>0.526944791</td>
<td>4.543942319</td>
<td>4.369804942</td>
<td>-0.16144</td>
<td>100</td>
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<tr>
<td></td>
<td>2</td>
<td>2,087.73</td>
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### Table 1: Fatigue Cracking

<table>
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<tr>
<th>Project</th>
<th>Lot</th>
<th>Target E* (ksi)</th>
<th>In-Situ E* (ksi)</th>
<th>Design Distress (%)</th>
<th>As-Built Distress (%)</th>
<th>Design Service Life (Yrs)</th>
<th>Predicted Service Life (Yrs)</th>
<th>PLD Factor</th>
<th>Design Fatigue Cracking (%)</th>
<th>As-Built Fatigue Cracking (%)</th>
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</thead>
<tbody>
<tr>
<td>SPT</td>
<td>1</td>
<td>1,135.77</td>
<td>1,478.15</td>
<td>0.348</td>
<td>0.063</td>
<td>26.103</td>
<td>68.664</td>
<td>42.56</td>
<td>110</td>
<td>0.35 0.21</td>
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<td>1,344.33</td>
<td>0.348</td>
<td>0.592</td>
<td>26.103</td>
<td>15.522</td>
<td>10.58</td>
<td>0.0</td>
<td>0.35 0.21</td>
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<tr>
<td>Standard A &amp; VTS</td>
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<td>1,135.77</td>
<td>1,317.25</td>
<td>0.348</td>
<td>0.344</td>
<td>26.103</td>
<td>18.195</td>
<td>7.91</td>
<td>0.0</td>
<td>0.35 0.21</td>
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<tr>
<td>Experimental A &amp; VTS</td>
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<td>1,507.00</td>
<td>0.348</td>
<td>0.026</td>
<td>26.103</td>
<td>131.582</td>
<td>105.48</td>
<td>110</td>
<td>0.35 0.21</td>
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<td>SPT - AS</td>
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<td>86.882</td>
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<td>127.16</td>
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<td>0.34 0.21</td>
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<tr>
<td>SPT - LC-UC E</td>
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<td>1,605.77</td>
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<td>0.60</td>
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<td>Experimental As</td>
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<td>1,537.49</td>
<td>1,528.00</td>
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<td>0.48</td>
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<td>7.23</td>
<td>-1.95</td>
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<tr>
<td>SPT - LC-UC E</td>
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<td>47.95</td>
<td>110.00</td>
<td>0.34 0.21</td>
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<tr>
<td>QRSS -</td>
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<td>Standard A &amp; VTS</td>
<td>2</td>
<td>1,537.49</td>
<td>1,300.91</td>
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<td>0.60</td>
<td>20.32</td>
<td>5.87</td>
<td>-1.15</td>
<td>0.0</td>
<td>0.34 0.21</td>
</tr>
<tr>
<td>Experimental A &amp; VTS</td>
<td>3</td>
<td>1,537.49</td>
<td>1,528.00</td>
<td>0.15</td>
<td>0.48</td>
<td>20.32</td>
<td>7.23</td>
<td>-1.95</td>
<td>0.0</td>
<td>0.34 0.21</td>
</tr>
<tr>
<td>Experimental As</td>
<td>4</td>
<td>1,537.49</td>
<td>1,678.65</td>
<td>0.15</td>
<td>0.03</td>
<td>20.32</td>
<td>68.27</td>
<td>47.95</td>
<td>110.00</td>
<td>0.34 0.21</td>
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<tr>
<td>SPT - LC-UC E</td>
<td>5</td>
<td>1,537.49</td>
<td>1,689.79</td>
<td>0.15</td>
<td>0.06</td>
<td>20.32</td>
<td>41.44</td>
<td>21.28</td>
<td>110.00</td>
<td>0.34 0.21</td>
</tr>
</tbody>
</table>
As Designed Mix

As Built Mix

Fatigue Cracking (%)
As Designed Mix

As Built Mix

Surface Rutting (inches)

- SMA+30%RAP (PG58-22) QRSS-Standard A & VTS
- SMA+30%RAP (PG58-22) QRSS-Experimental A & VTS
- SMA+10%RAP (PG64-22) SPT
- HMA + 10%RAP (PG64-28) QRSS-Standard A & VTS
- HMA + 10%RAP (PG64-28) QRSS-Experimental A & VTS
- HMA + 10%RAP (PG64-28) SPT

(0.05, 0.1, 0.15, 0.2, 0.25)
**Total Bituminous Layer Rutting PLD (Years)**

- **DGA HMA + 15%RAP (PG64-28) QRSS - Standard A & VTS**
- **DGA HMA + 15%RAP (PG64-28) QRSS - Experimental A & VTS**
- **DGA HMA + 15%RAP (PG64-28) SPT - PC-UC E***
- **DGA HMA + 15%RAP (PG64-28) SPT - LC-UC E***
- **DGA HMA + 15%RAP (PG64-28) SPT - LC-IDT E***

*Note: PC-UC, LC-UC, and LC-IDT refer to different test methods or conditions.*
SMA+30%RAP (PG58-22) QRSS - Standard A & VTS

SMA+30%RAP (PG58-22) QRSS - Experimental A & VTS

SMA+30%RAP (PG58-22) SPT

HMA + 10%RAP (PG64-28) QRSS - Standard A & VTS

HMA + 10%RAP (PG64-28) QRSS - Experimental A & VTS

HMA + 10%RAP (PG64-28) SPT
Fatigue Cracking PLD (Years)

- SMA+30%RAP (PG58-22) QRSS - Standard A & VTS
- SMA+30%RAP (PG58-22) QRSS - Experimental A & VTS
- SMA+30%RAP (PG58-22) SPT
- HMA + 10%RAP (PG64-28) QRSS - Standard A & VTS
- HMA + 10%RAP (PG64-28) QRSS - Experimental A & VTS
- HMA + 10%RAP (PG64-28) SPT
Surface Rutting Pay Factors (%)

Pay Factors

- C/160 HMA + 35%RAP (PG64-28) QRSS-Standard & VTS
- C/160 HMA + 35%RAP (PG64-28) QRSS-exp & VTS
- C/160 HMA + 35%RAP (PG64-28) SPT-LC UC E
- C/160 HMA + 35%RAP (PG64-28) SPT-LC IDT E
- WMA SMA + 10%RAP (PG64-28) QRSS-Standard & VTS
- WMA SMA + 10%RAP (PG64-28) QRSS-exp & VTS
- WMA SMA + 10%RAP (PG64-28) SPT-LC UC E
- WMA SMA + 10%RAP (PG64-28) SPT-LC IDT E
- DGA HMA + 15%RAP (PG64-28) QRSS-Standard A & VTS
- DGA HMA + 15%RAP (PG64-28) QRSS-exp A & VTS
- DGA HMA + 15%RAP (PG64-28) SPT-PC UC E
- DGA HMA + 15%RAP (PG64-28) SPT-PC IDT E
- DGA HMA + 15%RAP (PG64-28) SPT-LC UC E
- DGA HMA + 15%RAP (PG64-28) SPT-LC IDT E
- DGA HMA (PG64-28) QRSS - Experimental A & VTS
- DGA HMA (PG64-28) QRSS - Standard A & VTS
- DGA HMA (PG64-28) SPT-PC UC E*
Fatigue Cracking Pay Factors (%)

- C/160 HMA + 35%RAP (PG64-28) QRSS - standard A&VTS
- C/160 HMA + 35%RAP (PG64-28) QRSS - exp A&VTS
- C/160 HMA + 35%RAP (PG64-28) SPT-LC UC E*
- C/160 HMA + 35%RAP (PG64-28) SPT-LC IDT E*
- WMA SMA + 10%RAP (PG76-22) QRSS - standard A&VTS
- WMA SMA + 10%RAP (PG76-22) QRSS - exp A&VTS
- WMA SMA + 10%RAP (PG76-22) SPT-LC UC E*
- WMA SMA + 10%RAP (PG76-22) SPT-LC IDT E*
- DGA HMA + 15%RAP (PG64-28) SPT - PC-UC E*
- DGA HMA + 15%RAP (PG64-28) SPT - LC-UC E*
- DGA HMA + 15%RAP (PG64-28) SPT - LC-IDT E*
- DGA HMA (PG64-28) QRSS - (standard Binder values)
- DGA HMA (PG64-28) QRSS - (experimental Binder A&VTS)
- DGA HMA (PG64-28) SPT - LC-UC E*
APPENDIX D – CONFIDENCE INTERVAL ANALYSIS
HMA+35% RAP Lot #1 (DELDOT)

Dynamic Modulus, $E^*$ (psi)

Test Temperature and Frequency (Hz)

- 4.4C
- 20C
- 35C

- 25 Hz
- 10 Hz
- 5 Hz
- 1 Hz
- 0.5 Hz
- 0.1 Hz
HMA+35% RAP Lot #2 (DELDOT)

Dynamic Modulus, $E^*$ (psi)

Test Temperature and Frequency (Hz)

- 4.4°C
- 20°C
- 35°C

 Frequencies: 25, 10, 5, 1, 0.5, 0.1 Hz
WMA SMA+10% RAP Lot #1 (DELDOT)

Dynamic Modulus, $E^*$ (psi)

Test Temperature and Frequency (Hz)

- Unaxial
- IDT
WMA SMA+10% RAP Lot #3 (DELDOT)

Dynamic Modulus, $E^*$ (psi)

Test Temperature and Frequency (Hz)

- 4.4°C
- 20°C
- 35°C

 Frequencies:
- 0.1 Hz
- 0.5 Hz
- 1 Hz
- 5 Hz
- 10 Hz
- 25 Hz

Uniaxial
IDT
WMA SMA+10% RAP Lot #5 (DELDOT)

Dynamic Modulus, $E^*$ (psi)

Test Temperature and Frequency (Hz)

- 4.4°C, 25 Hz
- 4.4°C, 10 Hz
- 4.4°C, 5 Hz
- 4.4°C, 1 Hz
- 4.4°C, 0.5 Hz
- 4.4°C, 0.1 Hz
- 20°C, 25 Hz
- 20°C, 10 Hz
- 20°C, 5 Hz
- 20°C, 1 Hz
- 20°C, 0.5 Hz
- 20°C, 0.1 Hz
- 35°C, 25 Hz
- 35°C, 10 Hz
- 35°C, 5 Hz
- 35°C, 1 Hz
- 35°C, 0.5 Hz
- 35°C, 0.1 Hz