Shingle CPR™
CLEAN PROTECT REJUVENATE

## TEST RESULTS

| PROPERTIES | TEST METHOD | RESULTS | | | | | | | REQUIREMENT |
|---|---|---|---|---|---|---|---|---|---|
| Physical Property | | | | | | | | | |
| Granule Embedment, (g)<br>2 specimens; 50mm x 225mm<br>Cond. 30min at 73.4±3.6°F Test<br>50 complete cycles | ASTM D4977 | 1 | 2 | 3 | 4 | 5 | Avg. | St.Dev. | |
| | Sample B | 1.46 | 1.46 | 1.30 | 1.52 | 1.79 | 1.44 | 0.22 | Report |
| | Sample C | 2.36 | 2.56 | 2.47 | 1.82 | 1.69 | 2.18 | 0.36 | Report |
| Pliability (°F)<br>5 specimens; 25mm x 100mm;<br>Report lowest passing temp<br>Cond. 2±0.1h at temp Test 90°<br>around 1in (radius) in 2±0.5s<br>Visual Inspection | ASTM D497 | | | | | | | | |
| | Sample B | -20 | | | | | | | Report |
| | Sample C | -25 | | | | | | | Report |
| Notes: None | | | | | | | | | |

| PROPERTY | TEST METHOD | RESULTS | | | | | | | REQUIREMENT |
|---|---|---|---|---|---|---|---|---|---|
| | | #1 | #2 | #3 | #4 | #5 | Avg. | St.Dev. | |
| Procedure B (Wet Cup) | | | | | | | | | |
| Sample B<br>Water Method;<br>Test @ 73.4±1.8°F & 50±2 % RH | ASTM E 96 (Procedure B) | | | | | | | | |
| | Thickness (mil) | 123 | 123 | 128 | 125 | 130 | NA | NA | Report |
| | WT (gains/h-ft2) | 0.10 | 0.14 | 0.27 | 0.51 | 1.18 | 0.44 | 0.44 | Report |
| | Permeance (Perms) | 0.2 | 0.3 | 0.7 | 1.2 | 2.9 | 1.1 | 1.1 | Report |
| Sample C<br>Water Method;<br>Test @ 73.4±1.8°F & 50±2 % RH | ASTM E 96 (Procedure B) | | | | | | | | |
| | Thickness (mil) | 123 | 123 | 128 | 125 | 130 | NA | NA | Report |
| | WT (gains/h-ft2) | 4.31 | 5.31 | 4.34 | 3.70 | 4.43 | 4.42 | 0.58 | Report |
| | Permeance (Perms) | 10.5 | 13.0 | 10.6 | 9.0 | 10.8 | 10.8 | 1.4 | Report |

# Shingle CPR™

CLEAN PROTECT REJUVENATE

PRI

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Project No.: SUST 02-02-01/04

## SAMPLE DATA/INFORMATION:

| IDENTIFICATION | GRADE/TYPE | DATE RECEIVED | SOURCE |
|---|---|---|---|
| Shingle Rejuvenator Raw Materials | A | 4/22/2020 | Sustanture |
| | B | | |
| | C | | |
| | D | | |
| | E | | |
| AGED SHINGLES | 3 - Tab | 8/30/2019 | |

| INGREDIENTS | RESULTS; TRIAL #: Wt. %'s | | | |
|---|---|---|---|---|
| | -01 | -02 | -03 | -04 |
| A | 80.0 | 95.0 | 80.0 | 100.0 |
| B | 15.0 | -- | -- | -- |
| C | 5.0 | -- | -- | -- |
| D | -- | 5.0 | -- | -- |
| E | -- | -- | 20.0 | -- |

**OBJECTIVE:** Analyze shingle rejuvenators for preliminary properties associated with rejuvenating asphalts.

## CONCLUSIONS:

| PRODUCT | APPLICATION RATE | ACID # | PENETRATION | FLEXIBILITY/ CRACKING | COLOR CHANGE* | RUN OFF | GRANULAR ADHESION | RANK |
|---|---|---|---|---|---|---|---|---|
| BLEND -01 | 500 ft2/gal | 2 | 1 | 1 | **2** | **1** | 4 | 2 |
| BLEND -02 | | 1 | 1 | 2 | **3** | **1** | 3 | 2 |
| BLEND -03 | | 4 | 1 | 2 | **4** | **1** | 1 | 4 |
| BLEND -04 | | 2 | 1 | 1 | **1** | **1** | 2 | 1 |

* Color Change ranked from least change from control to most change from control. **As of 250 hours aging in QUV.**

## CONCLUSIONS: (continued)

- All rejuvenators improved flexibility
- All blends significantly improve granule adhesion
- All blends are excellent at penetration on application and improved further with time

**Table 2. Basic Properties of Rejuvenator Samples**

| PROPERTY | | TEST METHOD | RESULTS | | | |
|---|---|---|---|---|---|---|
| | | | Blend -01 | Blend -02 | Blend -03 | Blend -04 |
| SG | 25°C | D70 | 0.8902 | 0.8868 | 0.8914 | 0.8843 |
| Viscosity, cps | 4°C | D4402 / D2196 | 67.6 | 62.7 | 69.1 | 58.6 |
| | 25°C | | 48.0 | 44.0 | 48.0 | 40.0 |
| | 60°C | | 33.2 | 29.1 | 35.6 | 26.2 |
| Acid # | | D664 | 0.30 | 0.28 | 16.08 | 0.30 |

**Table 3. Penetration of 15# Asphalt Felt as a Function of Application Rate Over Time**

| RESULTS: Penetration Depth, mils (dmm) | | | | |
|---|---|---|---|---|
| PRODUCT | ON APPLICATION | 1 DAY AFTER APPLICATION | 3 DAYS AFTER APPLICATION | 7 DAYS AFTER APPLICATION |
| BLEND -01 | 20 (5.1) | 40 (10.2) | 80 (20.3) | 80(20.3) |
| BLEND -02 | 20 (5.1) | 40 (10.2) | 80 (20.3) | 80(20.3) |
| BLEND -03 | 20 (5.1) | 40 (10.2) | 80 (20.3) | 80(20.3) |
| BLEND -04 | 20 (5.1) | 40 (10.2) | 80 (20.3) | 80(20.3) |

*Samples were conditioned at 120±5°F

**Table 4. Flexibility/Cracking Shingle Mandrels**

| SAMPLE | APPLICATION RATE | TEMPERATURE | SIZE MANDREL WHEN CRACKING OBSERVED, INCHES |
|---|---|---|---|
| Control | NA | 4°C | 5/8 |
| BLEND -01 | 500 ft2/gal | | 1/2 |
| BLEND -02 | | | 3/8 |
| BLEND -03 | | | 3/8 |
| BLEND -04 | | | 1/2 |

*1x8 inch shingle pieces were treated with rejuvenator and cured for 24 hours at 25°C. Samples were then conditioned at 4°C for 1 hour and were bent 180° around a

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## Table 5A. QUV AGING // CIELAB Color and Change in Color for Shield Shield & Shingle AID

| BLEND | 500 SQFT/GAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hours | L* | a* | b* | ΔL* | Δa* | Δb* | ΔE* |
| Control | 0 | 46.26 | -1.83 | 2.73 | 0 | 0 | 0 | 0.00 |
| | 250 | 48.62 | -1.99 | 2.52 | 2.36 | -0.16 | -0.21 | 2.37 |
| | 500 | 48.47 | -2.09 | 2.92 | 2.21 | -0.26 | 0.19 | 2.23 |
| | 750 | 48.54 | -1.92 | | | | | |
| | 1000 | 48.14 | 3.01 | 2.28 | -0.09 | 0.28 | 2.30 | |
| Blend-01 | 0 | 35.7 | -2.15 | 2.95 | 1.88 | -0.32 | 0.22 | 1.92 |
| | 250 | 40.74 | 0.12 | 7.23 | -10.56 | 1.95 | 4.5 | 11.64 |
| | 500 | 43.95 | 0.18 | 4.5 | -5.52 | 2.01 | 1.77 | 6.14 |
| | 750 | | 0 | 3.95 | -2.31 | 1.83 | 1.22 | 3.19 |
| | 1000 | | | | | | | |
| Blend-02 | 0 | 36.1 | | | | | | |
| | 250 | 40.48 | 0.17 | 6.07 | -10.16 | 2 | 3.34 | 10.88 |
| | 500 | 43.77 | 0.18 | 4.2 | -5.78 | 2.01 | 1.47 | 6.29 |
| | 750 | | 0.22 | 4.25 | -2.49 | 2.05 | 1.52 | 3.57 |
| | 1000 | | | | | | | |
| Blend-03 | 0 | 34.62 | | | | | | |
| | 250 | 40.12 | 0.28 | 6.19 | -11.64 | 2.11 | 3.46 | 12.33 |
| | 500 | 45.24 | 0.23 | 4.29 | -6.14 | 2.06 | 1.56 | 6.66 |
| | 750 | | 0.2 | 4.54 | -1.02 | 2.03 | 1.81 | 2.90 |
| | 1000 | | | | | | | |
| Blend-04 | 0 | 35.92 | | | | | | |
| | 250 | 42.79 | 0.15 | 5.58 | -10.34 | 1.98 | 2.85 | 10.91 |
| | 500 | 44.97 | -0.25 | 3.46 | -3.47 | 1.58 | 0.73 | 3.88 |
| | 750 | | -0.31 | 3.37 | -1.29 | 1.52 | 0.64 | 2.09 |
| | 1000 | | | | | | | |

## Table 6A. Explanation of Color Values

| VALUE | EXPLANATION | POSITIVE VALUE | NEGATIVE VALUE |
|---|---|---|---|
| ΔL* | Difference in lightness/darkness value | Lighter | Darker |
| Δa* | Difference on red/green axis | Redder | Greener |
| Δb* | Difference on yellow/blue axis | Yellower | Bluer |
| ΔE | Total color difference value | Nearer to zero is closer to the color of the control at 0 | |

**Table 7. Granule Adhesion of Both Treated and Control Shingles**

| CONDITIONED 140°F FOR 7 DAYS | REPLICATE 1 | | REPLICATE 2 | | AVERAGE | |
|---|---|---|---|---|---|---|
| | UNTREATED | TREATED | UNTREATED | TREATED | UNTREATED | TREATED |
| BLEND -01 | -0.64 (-1.35) | -0.11 (-0.24) | -0.31 (-0.65) | -0.14 (-0.29) | -0.48 (-1.00) | -0.13 (-0.27) |
| BLEND -02 | -1.04 (-2.18) | -0.11 (-0.23) | -0.36 (-0.76) | -0.04 (-0.07) | -0.7 (-1.47) | -0.08 (-0.15) |
| BLEND -03 | -0.87 (-1.85) | -0.04 (-0.09) | -0.56 (-1.17) | -0.03 (-0.06) | -0.72 (-1.51) | -0.04 (-0.08) |
| BLEND -04 | -0.48 (-1.06) | -0.05 (-0.10) | -0.63 (-1.33) | -0.04 (-0.07) | -0.56 (-1.20) | -0.05 (-0.09) |

*% loss is of the total strip weight of the sample. Industry accepted loss is 1.0 g per 2"x9" Strip.
**Each product and application weight were run on separate tabs from shingles. 2 strips were cut from each tab.

## DISCUSSION:

All blends improve performance of shingles. 500 ft2/gal as an application rate improvse flexibility and granule adhesion over control while and does result in puddling and or product run off.

# APPENDIX A:
# PICTURES: 0 HOURS

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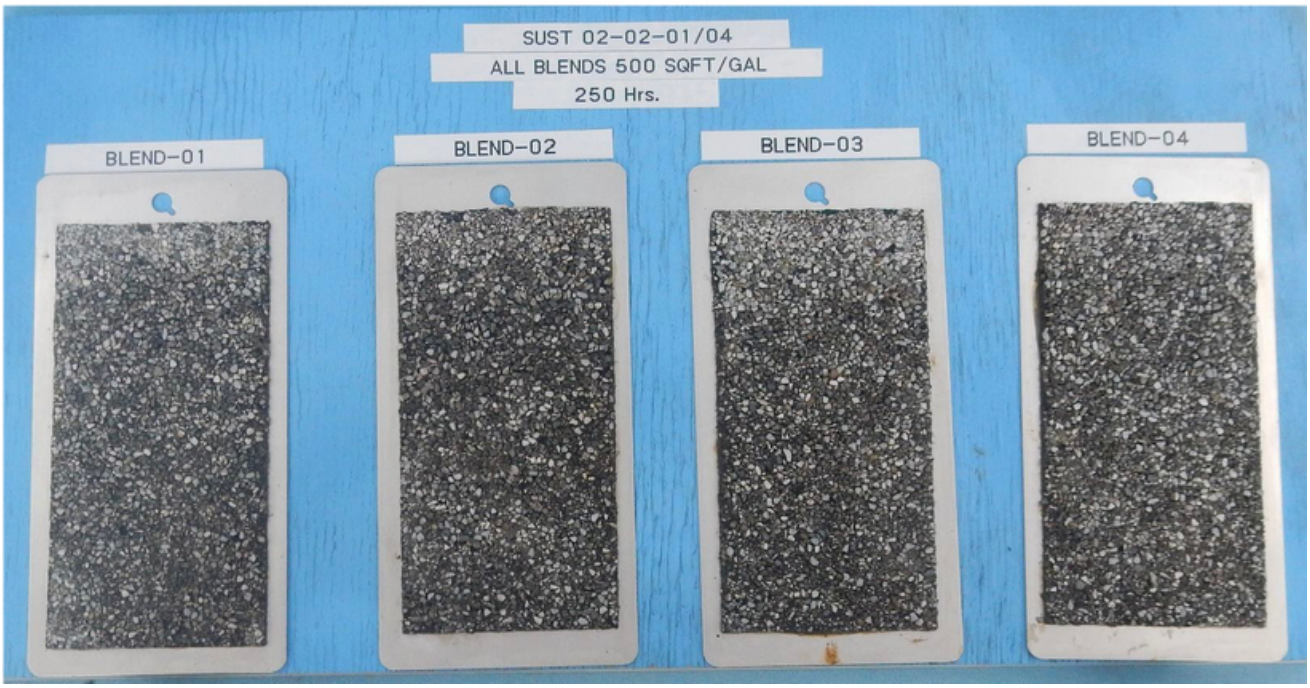
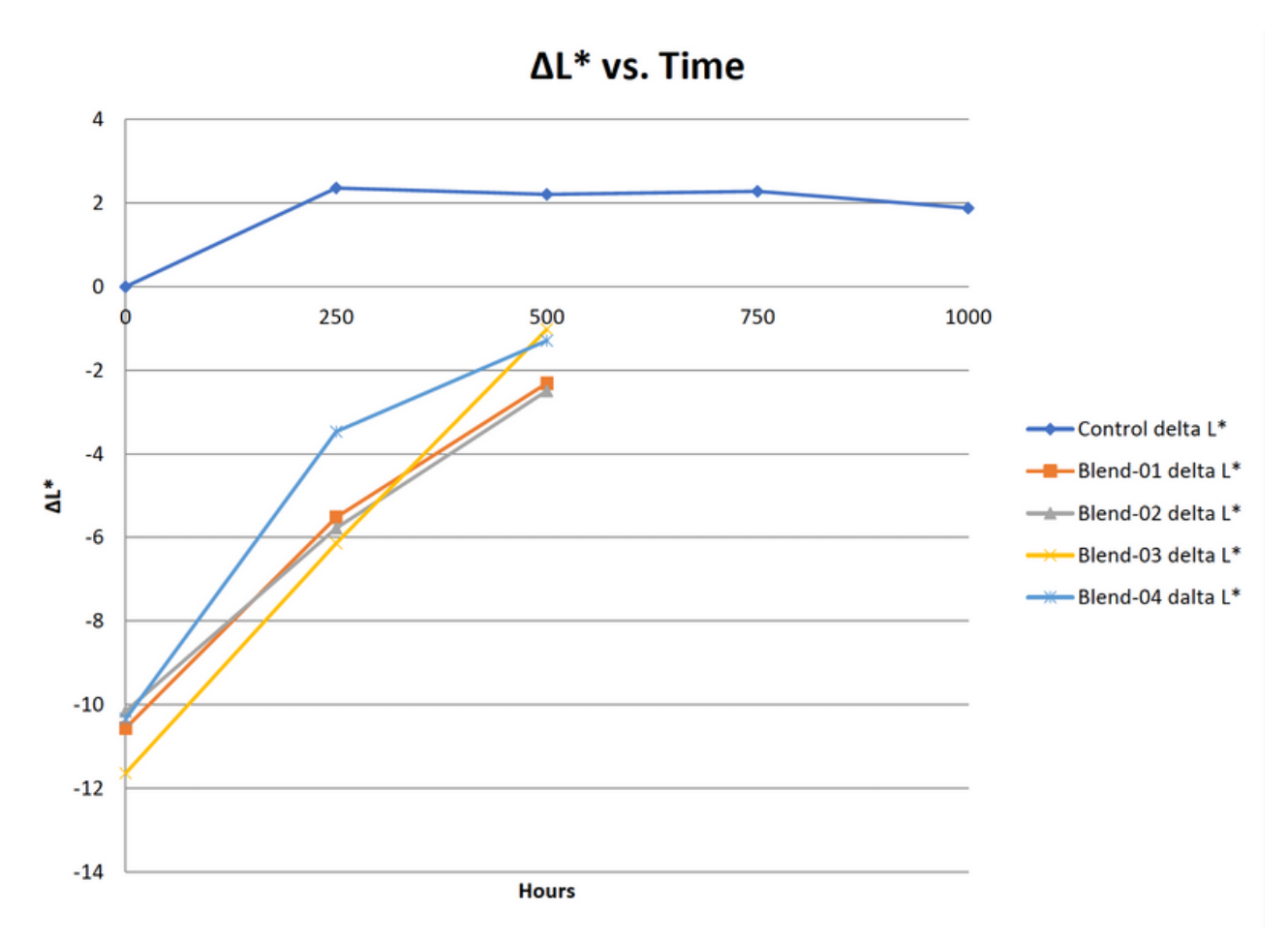
# APPENDIX A:
# PICTURES: 250 HOURS

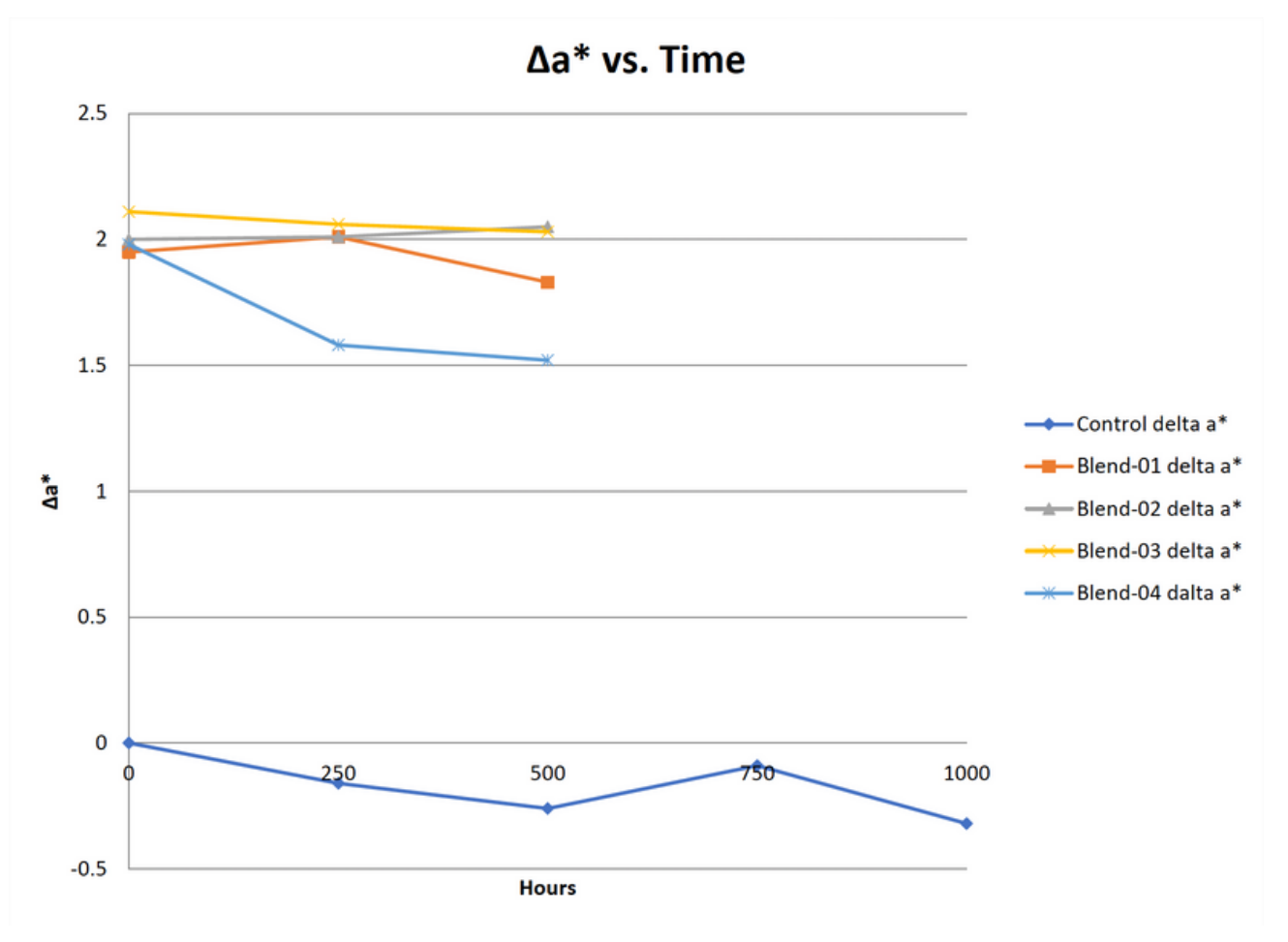
ASPHALT TECHNOLOGIES, INC.

Sustanture
SUST 01-02-01/04



# APPENDIX B:
# COLOR PLOT 1



## APPENDIX B:

# COLOR PLOT 2