



## Design Summary

Mix Type: RC Type 5-01

Date: March 14, 2020

Project: Various

Mix Design No.: K0503G

| Material Description                                             | Percent              | Source                             |       |                  |            |
|------------------------------------------------------------------|----------------------|------------------------------------|-------|------------------|------------|
| Greenwood 3/4" (#754)                                            | 19.0                 | Greenwood, MO                      |       |                  |            |
| Greenwood Dry 3/8" (#932)                                        | 11.0                 | Greenwood, MO                      |       |                  |            |
| Greenwood MS (#952)                                              | 20.0                 | Greenwood, MO                      |       |                  |            |
| Bingham Drag Sand                                                | 5.0                  | Picher, OK                         |       |                  |            |
| Holliday Nat Sand                                                | 15.0                 | Randolph, MO                       |       |                  |            |
| Baghouse Fines                                                   | ( Designed w/ 0.5% ) | Asphalt Plant                      |       |                  |            |
| KC Fine RAP                                                      | 25.0                 | Ideker Asphalt Plant               |       |                  |            |
| KC Coarse RAP                                                    | 5.0                  | Ideker Asphalt Plant               |       |                  |            |
| Phillips 66 PG58-28                                              | 4.6                  | Phillips 66 - Kansas City, MO      |       |                  |            |
| Sieve Size<br>(Sieve No.)                                        | Job Mix Formula      | Master Grading Limits<br>% Passing |       | JMF<br>Tolerance | Sieve Gap  |
| 37.5 mm (1-1/2")                                                 | 100.0                |                                    |       | ±5               |            |
| 25.0 mm (1")                                                     | 100.0                |                                    | 100.0 | ±5               |            |
| 19.0 mm (3/4")                                                   | 100.0                | 95.0                               | 100.0 | ±5               |            |
| 12.5 mm (1/2")                                                   | 89.8                 |                                    |       | ±5               |            |
| 9.5 mm (3/8")                                                    | 82.0                 |                                    |       | ±5               |            |
| 4.75 mm (#4)                                                     | 62.6                 |                                    |       | ±5               |            |
| 2.36 mm (#8)                                                     | 38.9                 | 28.0                               |       | ±4               |            |
| 1.18 mm (#16)                                                    | 25.3                 |                                    |       | ±4               |            |
| 600 mm (#30)                                                     | 15.9                 |                                    |       | ±4               |            |
| 300 mm (#50)                                                     | 11.4                 |                                    |       | ±4               |            |
| 150 mm (#100)                                                    | 6.9                  |                                    |       |                  |            |
| 75 um (#200)                                                     | 5.0                  | 2.0                                | 6.0   | ±2               |            |
| Mixture Property                                                 |                      | Design Value                       |       | Spec. Min.       | Spec. Max. |
| Optimum Binder Content, %                                        |                      | 4.6                                |       | -----            | -----      |
| Air Voids (V <sub>A</sub> ), %                                   |                      | 3.8                                |       | 3                | 5          |
| Voids in Mineral Aggregate (VMA), %                              |                      | 14.0                               |       | 13               | -----      |
| Virgin AC Added %                                                |                      | 3.03                               |       | -----            | -----      |
| AC From RAP                                                      |                      | 1.57                               |       | -----            | -----      |
| AC From Shingles                                                 |                      |                                    |       | -----            | -----      |
| Voids Filled with Asphalt (VFA), %                               |                      | 73.0                               |       | 65               | 75         |
| Stability (pounds)                                               |                      |                                    |       | -----            | -----      |
| Flow (in.)                                                       |                      |                                    |       | -----            | -----      |
| Dust Proportion (Based on Effective Binder Content)              |                      | 1.0                                |       | 0.6              | 1.2        |
| %G <sub>mm</sub> @ N <sub>ini</sub>                              |                      | 87.6%                              |       | -----            | 90.5       |
| %G <sub>mm</sub> @ N <sub>max</sub>                              |                      | 97.2%                              |       | -----            | 98.0       |
| TSR                                                              |                      | 82.5                               |       | 75.0             | -----      |
| Fractured Faces (% with 1 face / % with 2 faces)                 |                      | 100 / 96                           |       | 85 /             | -----      |
| Flat & Elongated (F&E) (5:1), %                                  |                      | 2                                  |       | -----            | 20.0       |
| Unit Weight, pcf                                                 |                      | 148.3                              |       |                  |            |
| Mixing Temperature, °F                                           |                      | 300 - 315                          |       |                  |            |
| Compaction Temperature, °F                                       |                      | 282 - 292                          |       |                  |            |
| Combined Bulk Specific Gravity of Aggregate, G <sub>sb</sub>     |                      | 2.636                              |       |                  |            |
| Combined Apparent Specific Gravity of Aggregate, G <sub>sa</sub> |                      | 2.712                              |       |                  |            |
| Effective Specific Gravity of Aggregate, G <sub>se</sub>         |                      | 2.648                              |       |                  |            |
| Binder Specific Gravity (@ 77 °F), G <sub>b</sub>                |                      | 1.030                              |       |                  |            |



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#### Project Information

|                  |                    |                     |                 |
|------------------|--------------------|---------------------|-----------------|
| Mix Type:        | RC Type 5-01       | Date:               | April 18, 2020  |
| Project No:      | Various            | County:             | Various         |
| Route:           | Various            | Mix Design No:      | K0503G          |
| Compaction Type: | Superpave Gyratory | Number of Gyration: | 75 Gyros (Nmax) |

#### Virgin Aggregates

| Description               | Material ID | Quarry Location | Ledge  | % Absorption | % Chert | P.I.  | Gsb   | Gsa   | C142 | C131 | C88    | Org. Content |
|---------------------------|-------------|-----------------|--------|--------------|---------|-------|-------|-------|------|------|--------|--------------|
| Greenwood 3/4" (#754)     | ----        | Greenwood, MO   | BF 1-4 | 1.6          | 0       | ----- | 2.597 | 2.713 | 0.1  | 24   | Na - 7 |              |
| Greenwood Dry 3/8" (#932) | ----        | Greenwood, MO   | BF 1-4 | 1.8          | 0       | ----- | 2.591 | 2.717 | 0.1  | 24   | Na - 7 |              |
| Greenwood MS (#952)       | ----        | Greenwood, MO   | BF 1-4 | 1.8          | 0       | 1     | 2.562 | 2.689 | 0.1  | 24   | Na - 7 | 0.01         |
| Bingham Drag Sand         | ----        | Picher, OK      | Chat   | 1.5          | 0       | ----- | 2.543 | 2.647 |      |      |        | 0.05         |
| Holliday Nat Sand         | ----        | Randolph, MO    | Sand   | 0.7          | 0       | ----- | 2.623 | 2.670 |      |      |        | 0.10         |
|                           |             |                 |        |              |         |       |       |       |      |      |        |              |
| Baghouse Fines            | ----        | Asphalt Plant   | ----   |              | 0       | ----- | 2.550 | 2.550 |      |      |        |              |

#### Recycled Materials

| Description   | Material ID | Producer             | Source         | AC Content | Gmm   | Gse   |
|---------------|-------------|----------------------|----------------|------------|-------|-------|
| KC Fine RAP   | ----        | Ideker Asphalt Plant | MoDot Projects | 5.5        | 2.526 | 2.757 |
| KC Coarse RAP | ----        | Ideker Asphalt Plant | MoDot Projects | 4.1        | 2.584 | 2.761 |

#### Asphaltic Cement

| Description         | Material ID | Producer                      | PG Grade | Sp. Gr. | Mixing Temp | Compaction Temp |
|---------------------|-------------|-------------------------------|----------|---------|-------------|-----------------|
| Phillips 66 PG58-28 | ----        | Phillips 66 - Kansas City, MO | PG58-28  | 1.030   | 300 - 315   | 282 - 292       |

#### Chemical Additives / Mineral Fillers

| Description | Material ID | Producer / Location | Sp. Gr. | Percent / Dosage |
|-------------|-------------|---------------------|---------|------------------|
|             |             |                     |         |                  |
|             |             |                     |         |                  |
|             |             |                     |         |                  |

#### Additional Comments

### Gradation without Bag House Fines

| Sieve Size         | Greenwood 3/4" (#754) | Greenwood Dry 3/8" (#932) | Greenwood MS (#952) | Bingham Drag Sand | Holliday Nat Sand |  | Baghouse Fines       | KC Fine RAP | KC Coarse RAP |  | Cold Feed | Blend | JMF           |
|--------------------|-----------------------|---------------------------|---------------------|-------------------|-------------------|--|----------------------|-------------|---------------|--|-----------|-------|---------------|
|                    | 19.0                  | 11.0                      | 20.0                | 5.0               | 15.0              |  | ( Designed w/ 0.5% ) | 25.0        | 5.0           |  | 100.0     | 100.0 | Master Limits |
| 37.5 mm ( 1-1/2" ) | 100.0                 | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0                | 100.0       | 100.0         |  | 70.0      | 100.0 |               |
| 25.0 mm ( 1" )     | 100.0                 | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0                | 100.0       | 100.0         |  | 70.0      | 100.0 | 100           |
| 19.0 mm (3/4")     | 100.0                 | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0                | 100.0       | 100.0         |  | 70.0      | 100.0 | 95 100        |
| 12.5 mm (1/2")     | 58.0                  | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0                | 91.0        | 100.0         |  | 62.0      | 89.8  |               |
| 9.5 mm (3/8")      | 40.0                  | 99.0                      | 100.0               | 100.0             | 100.0             |  | 100.0                | 74.0        | 99.0          |  | 58.5      | 81.9  |               |
| 4.75 mm (#4)       | 15.0                  | 65.0                      | 94.0                | 98.0              | 99.0              |  | 100.0                | 38.0        | 88.0          |  | 48.6      | 62.5  |               |
| 2.36 mm (#8)       | 4.0                   | 15.0                      | 42.0                | 69.0              | 85.0              |  | 100.0                | 35.0        | 57.0          |  | 27.0      | 38.6  | 28            |
| 1.18 mm (#16)      | 4.0                   | 8.0                       | 24.0                | 41.0              | 51.0              |  | 100.0                | 26.0        | 45.0          |  | 16.1      | 24.9  |               |
| 600 mm (#30)       | 3.0                   | 7.0                       | 11.0                | 24.0              | 28.0              |  | 100.0                | 20.0        | 31.0          |  | 8.9       | 15.5  |               |
| 300 mm (#50)       | 3.0                   | 6.0                       | 7.0                 | 16.0              | 16.0              |  | 97.0                 | 15.0        | 28.0          |  | 5.8       | 11.0  |               |
| 150 mm (#100)      | 3.0                   | 5.0                       | 5.0                 | 7.4               | 4.0               |  | 95.0                 | 10.0        | 18.0          |  | 3.1       | 6.5   |               |
| 75 um (#200)       | 2.4                   | 4.2                       | 4.2                 | 3.2               | 0.7               |  | 93.0                 | 7.5         | 12.9          |  | 2.0       | 4.5   | 2 6           |
| Gsb                | 2.597                 | 2.591                     | 2.562               | 2.543             | 2.623             |  | 2.550                | 2.757       | 2.761         |  |           | 2.636 |               |
| Gsa                | 2.713                 | 2.717                     | 2.689               | 2.647             | 2.670             |  | 2.550                | 2.757       | 2.761         |  |           | 2.712 |               |
| Pb                 |                       |                           |                     |                   |                   |  |                      | 5.47        | 4.08          |  |           |       |               |

### Gradation with Bag House Fines

| Sieve Size         | Greenwood 3/4" (#754) | Greenwood Dry 3/8" (#932) | Greenwood MS (#952) | Bingham Drag Sand | Holliday Nat Sand |  | Baghouse Fines | KC Fine RAP | KC Coarse RAP |  | Cold Feed | Blend | JMF           |
|--------------------|-----------------------|---------------------------|---------------------|-------------------|-------------------|--|----------------|-------------|---------------|--|-----------|-------|---------------|
|                    | 18.9                  | 10.9                      | 19.9                | 4.9               | 14.9              |  | 0.5            | 25.0        | 5.0           |  | 100.0     | 100.0 | Master Limits |
| 37.5 mm ( 1-1/2" ) | 100.0                 | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0          | 100.0       | 100.0         |  | 70.0      | 100.0 |               |
| 25.0 mm ( 1" )     | 100.0                 | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0          | 100.0       | 100.0         |  | 70.0      | 100.0 | 100           |
| 19.0 mm (3/4")     | 100.0                 | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0          | 100.0       | 100.0         |  | 70.0      | 100.0 | 95 100        |
| 12.5 mm (1/2")     | 58.0                  | 100.0                     | 100.0               | 100.0             | 100.0             |  | 100.0          | 91.0        | 100.0         |  | 62.1      | 89.8  |               |
| 9.5 mm (3/8")      | 40.0                  | 99.0                      | 100.0               | 100.0             | 100.0             |  | 100.0          | 74.0        | 99.0          |  | 58.6      | 82.0  |               |
| 4.75 mm (#4)       | 15.0                  | 65.0                      | 94.0                | 98.0              | 99.0              |  | 100.0          | 38.0        | 88.0          |  | 48.7      | 62.6  |               |
| 2.36 mm (#8)       | 4.0                   | 15.0                      | 42.0                | 69.0              | 85.0              |  | 100.0          | 35.0        | 57.0          |  | 27.3      | 38.9  | 28            |
| 1.18 mm (#16)      | 4.0                   | 8.0                       | 24.0                | 41.0              | 51.0              |  | 100.0          | 26.0        | 45.0          |  | 16.5      | 25.3  |               |
| 600 mm (#30)       | 3.0                   | 7.0                       | 11.0                | 24.0              | 28.0              |  | 100.0          | 20.0        | 31.0          |  | 9.4       | 15.9  |               |
| 300 mm (#50)       | 3.0                   | 6.0                       | 7.0                 | 16.0              | 16.0              |  | 97.0           | 15.0        | 28.0          |  | 6.3       | 11.4  |               |
| 150 mm (#100)      | 3.0                   | 5.0                       | 5.0                 | 7.4               | 4.0               |  | 95.0           | 10.0        | 18.0          |  | 3.5       | 6.9   |               |
| 75 um (#200)       | 2.4                   | 4.2                       | 4.2                 | 3.2               | 0.7               |  | 93.0           | 7.5         | 12.9          |  | 2.5       | 5.0   | 2 6           |
| Gsb                | 2.597                 | 2.591                     | 2.562               | 2.543             | 2.623             |  | 2.550          | 2.757       | 2.761         |  |           | 2.636 |               |
| Gsa                | 2.713                 | 2.717                     | 2.689               | 2.647             | 2.670             |  | 2.550          | 2.757       | 2.761         |  |           | 2.711 |               |
| Pb                 |                       |                           |                     |                   |                   |  |                | 5.47        | 4.08          |  |           |       |               |

## HOT MIXED ASPHALT PROPERTIES

Location: Mosby, MO AC Specific Gravity ( $G_c$ )= 1.030

Compaction: Superpave Gyratory Effective Specific Gravity of Aggregate ( $G_{se}$ )= 2.648

Grade AC: Phillips 66 PG58-28 Number of Gyration: 75 Gyros ( $N_{max}$ ) Bulk Specific Gravity of Aggregate ( $G_{sb}$ )= 2.636

| General         |                     |                      | Weights    |              |         | Mix Volume  | Specific Gravities |         | Volumes               |                  | Unit Weight       | Voids  |         |         | Marshall Info |             |                  |                  |                   |                   |       |       |
|-----------------|---------------------|----------------------|------------|--------------|---------|-------------|--------------------|---------|-----------------------|------------------|-------------------|--------|---------|---------|---------------|-------------|------------------|------------------|-------------------|-------------------|-------|-------|
| Specimen Number | Asphalt Content (%) | Average Height (in.) | In Air (g) | In Water (g) | SSD (g) | Volume (cc) | Bulk Gmb           | TMD Gmm | Aggregate Volume (cc) | AC by Volume (%) | Unit Weight (pcf) | VA (%) | VMA (%) | VFA (%) | Measured (lb) | Flow ( in.) | Ht @ Nini ( mm ) | Ht @ Nmax ( mm ) | %Gmm @ Nini ( % ) | %Gmm @ Nmax ( % ) |       |       |
| 1A              | 4.1                 | 115.40               | 4703.0     | 2726.7       | 4720.3  | 1993.6      | 2.359              |         |                       |                  | 147.2             |        |         |         |               |             | 126.6            | 113.8            | 85.8%             | 95.5%             |       |       |
| 1B              | 4.1                 | 115.30               | 4703.4     | 2723.6       | 4721.7  | 1998.1      | 2.354              |         |                       |                  | 146.9             |        |         |         |               |             |                  |                  | 126.5             | 113.8             | 85.8% | 95.4% |
| 1C              | 4.1                 |                      |            |              |         |             |                    |         |                       |                  |                   |        |         |         |               |             |                  |                  |                   |                   |       |       |
| Average         |                     |                      |            |              |         |             | 2.356              | 2.503   | 85.7                  | 9.4              | 147.0             | 5.8    | 14.3    | 59.1    |               |             |                  |                  |                   |                   |       |       |
| 2A              | 4.6                 | 114.10               | 4701.6     | 2733.8       | 4711.2  | 1977.4      | 2.378              |         |                       |                  | 148.4             |        |         |         |               |             | 125.3            | 112.9            | 87.6%             | 97.2%             |       |       |
| 2B              | 4.6                 | 114.00               | 4700.1     | 2731.5       | 4710.8  | 1979.3      | 2.375              |         |                       |                  | 148.2             |        |         |         |               |             |                  |                  | 125.2             | 112.8             | 87.6% | 97.2% |
| 2C              | 4.6                 |                      |            |              |         |             |                    |         |                       |                  |                   |        |         |         |               |             |                  |                  |                   |                   |       |       |
| Average         |                     |                      |            |              |         |             | 2.376              | 2.470   | 86.0                  | 10.6             | 148.3             | 3.8    | 14.0    | 73.0    |               |             |                  |                  | 87.6%             | 97.2%             |       |       |
| 3A              | 5.1                 | 112.80               | 4701.8     | 2736.5       | 4706.3  | 1969.8      | 2.387              |         |                       |                  | 148.9             |        |         |         |               |             | 124.4            | 111.1            | 88.4%             | 99.0%             |       |       |
| 3B              | 5.1                 | 112.60               | 4697.5     | 2741.1       | 4702.0  | 1960.9      | 2.396              |         |                       |                  | 149.5             |        |         |         |               |             |                  |                  | 124.1             | 110.9             | 88.5% | 99.0% |
| 3C              | 5.1                 |                      |            |              |         |             |                    |         |                       |                  |                   |        |         |         |               |             |                  |                  |                   |                   |       |       |
| Average         |                     |                      |            |              |         |             | 2.391              | 2.452   | 86.1                  | 11.8             | 149.2             | 2.5    | 13.9    | 82.1    |               |             |                  |                  |                   |                   |       |       |
| 4A              | 5.6                 |                      |            |              |         |             |                    |         |                       |                  |                   |        |         |         |               |             |                  |                  |                   |                   |       |       |
| 4B              | 5.6                 |                      |            |              |         |             |                    |         |                       |                  |                   |        |         |         |               |             |                  |                  |                   |                   |       |       |
| 4C              | 5.6                 |                      |            |              |         |             |                    |         |                       |                  |                   |        |         |         |               |             |                  |                  |                   |                   |       |       |
| Average         |                     |                      |            |              |         |             |                    |         |                       |                  |                   |        |         |         |               |             |                  |                  |                   |                   |       |       |

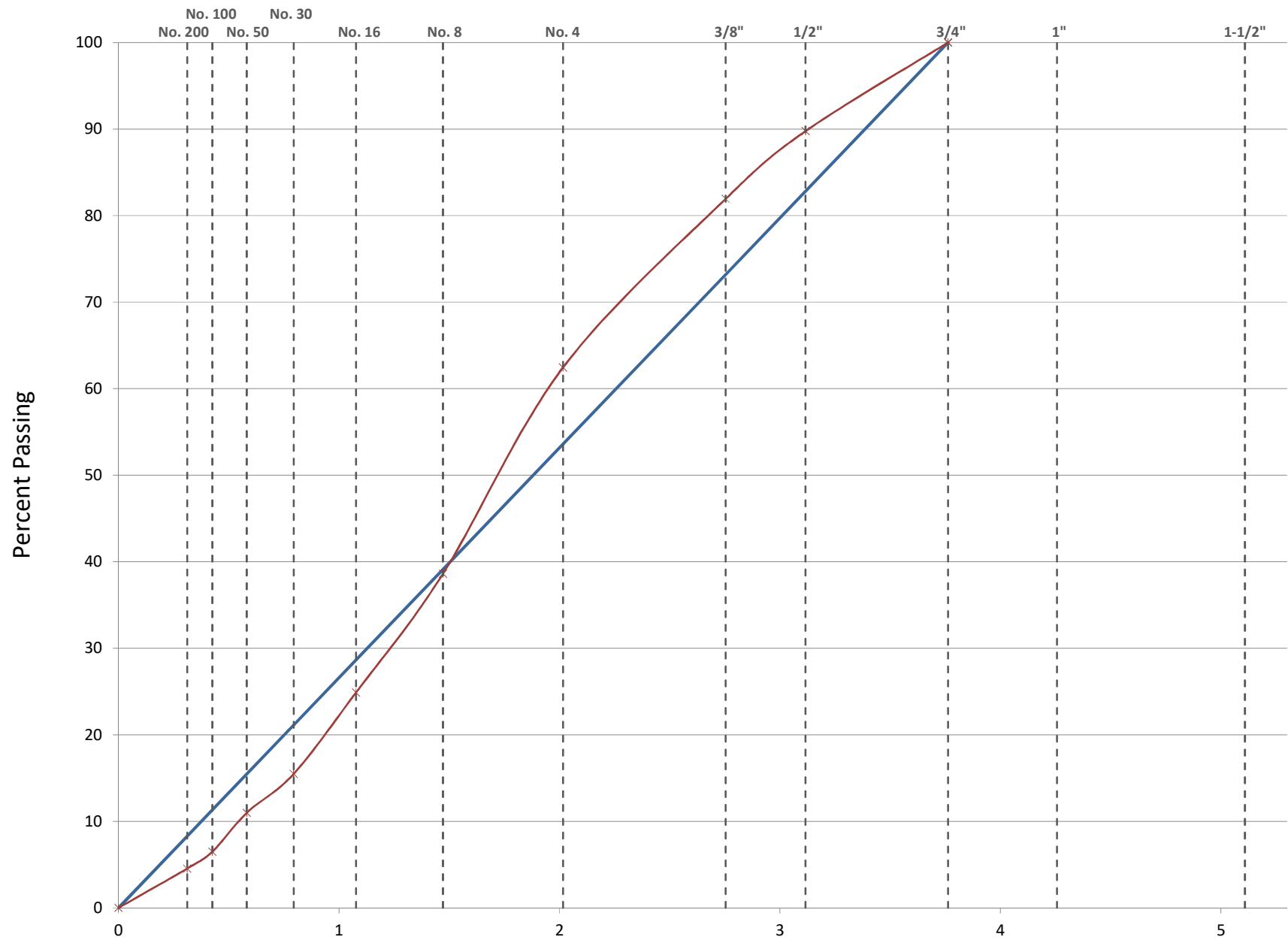
| Binder Content, % | Effective Binder, % | Dust Proportion |
|-------------------|---------------------|-----------------|
| 4.1               | 3.9                 | 1.2             |
| 4.6               | 4.4                 | 1.0             |
| 5.1               | 4.9                 | 0.9             |
| 5.6               | 5.4                 | 0.8             |

Mix Type: RC Type 5-01

Date: 03/14/20

Project: Various

| Theoretical Maximum Specific Gravity<br>( AASHTO T209 / ASTM D 2041 ) |              |         |              |         |              |         |         |         |
|-----------------------------------------------------------------------|--------------|---------|--------------|---------|--------------|---------|---------|---------|
| AC Content                                                            | 4.1          | 4.1     | 4.6          | 4.6     | 5.1          | 5.1     | 5.6     | 5.6     |
|                                                                       | Bowl #1      | Bowl #2 | Bowl #1      | Bowl #2 | Bowl #1      | Bowl #2 | Bowl #1 | Bowl #2 |
| Weight of Sample                                                      | 1563.2       |         | 1709.9       |         | 1682.4       |         |         |         |
| Weight of Sample (dry back)                                           | 1563.2       |         | 1709.9       |         | 1682.4       |         |         |         |
| Weight of flask ( Calibration )                                       | 1347.8       |         | 1347.8       |         | 1347.8       |         |         |         |
| Weight of flask filled with water and sample                          | 2286.4       |         | 2365.3       |         | 2344.2       |         |         |         |
| G <sub>mm</sub>                                                       | 2.503        |         | 2.470        |         | 2.452        |         |         |         |
| <b>Average G<sub>mm</sub></b>                                         | <b>2.503</b> |         | <b>2.470</b> |         | <b>2.452</b> |         |         |         |
| G <sub>mm</sub> ( dry back )                                          | 2.503        |         | 2.470        |         | 2.452        |         |         |         |
| <b>Average G<sub>mm</sub> ( dry back )</b>                            | <b>2.503</b> |         | <b>2.470</b> |         | <b>2.452</b> |         |         |         |



--- Max Density Line

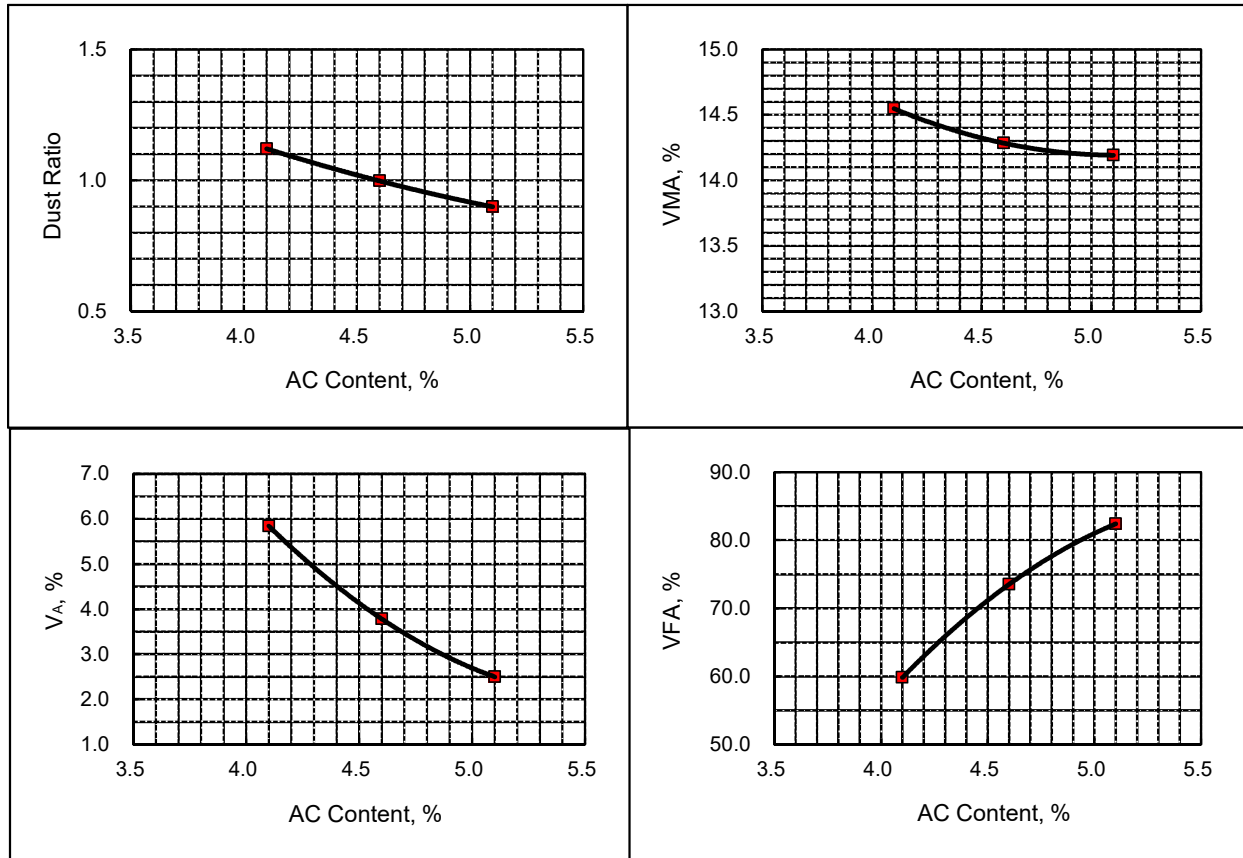
0.45 Power Chart

--x-- Gradation

# HOT MIXED ASPHALT PROPERTY CURVES

Mix Type: RC Type 5-01

Project: Various



| AC Content (%) | Dust Ratio | Stability (lb) | Flow (0.01 in.) | VMA (%) | VFA (%) | V <sub>A</sub> |
|----------------|------------|----------------|-----------------|---------|---------|----------------|
| 4.1            | 1.1        |                |                 | 14.5    | 59.8    | 5.8            |
| 4.6            | 1.0        |                |                 | 14.3    | 73.5    | 3.8            |
| 5.1            | 0.9        |                |                 | 14.2    | 82.4    | 2.5            |