

March 5, 2019



Connell Resources, Inc.
7785 Highland Meadows Parkway, Suite 100
Fort Collins, Colorado 80528

Attn: Mr. Ed Wells (ewells@connellresources.com)

Re: Connell Resources, Inc. - 2019 Asphalt Mix Designs
Mix #22050, Grading S 75 (Suncor 58-28) with Lime
EEC Project No. 1195001A-7

Mr. Wells:

Earth Engineering Consultants, LLC (EEC) personnel have completed the requested laboratory Superpave mix design for the referenced asphaltic concrete mix. The mix design was completed in general accordance with Colorado Department of Transportation and Asphalt Institute Superpave Mix Design No. 2 mix design procedures as well as Larimer County Urban Area Street Standards requirements. The mix design was performed using a Superpave Gyrotory Compactor with a compaction angle of 1.25 degrees and 100-mm molds. In addition, specified tests were completed on the component aggregate. Results of the testing completed for this mix and recommendations for the job mix formula are provided in this report.

The asphaltic concrete job mix formula provided with this report is based on testing completed with specific materials, gradations and design procedures. Variation in laboratory test results can occur due to multi-laboratory precision, variation in materials and slight changes in design procedures. These factors should be considered when job mix verification of laboratory mixes is performed. The physical properties of the mix should be retested and re-evaluated for hot plant produced material. It is often necessary to make adjustments to the job mix formula to account for the changed environment between the laboratory and field produced material. Should the source or physical characteristics of the materials change substantially, the development of a new or revised job mix formula is recommended.

We appreciate the opportunity to be of service to you. If you have any questions regarding this report, or if we can be of further service to you in any other way, please do not hesitate to contact us.

Very truly yours,
Earth Engineering Consultants, LLC



Ethan P. Wiechert, P.E.
Senior Project Engineer

4396 GREENFIELD DRIVE
WINDSOR, COLORADO 80550
(970) 545-3908 FAX (970) 663-0282
www.earth-engineering.com

EARTH ENGINEERING CONSULTANTS, LLC
ASPHALTIC CONCRETE MIX DESIGN
 Connell Resources, Inc. - Mix No. 22050
 Superpave Mix Design: Grading S 75 (Suncor PG 58-28) with Lime

TABLE I - AGGREGATE GRADATIONS

Sieve Size	Connell	Connell	Connell	Connell	Connell			Pete Lien	Composite	Job Mix Tolerance	Target Master Range
	Carr	Carr	Carr	Carr	Timnath			Lime			
	3/4"	Crusher Fines	W. Crusher Fines	Naturals	RAP AC=5.12%						
1 1/2" (37.5 mm)	100	100	100	100	100			100	100	100	
1" (25.0 mm)	100	100	100	100	100			100	100	100	100
3/4" (19.0 mm)	100	100	100	100	100			100	100	90 - 100	90 - 100
1/2" (12.5 mm)	62	100	100	100	99			100	88	82 - 94	
3/8" (9.5 mm)	37	100	100	99	95			100	80	74 - 86	
No. 4 (4.75 mm)	2	82	85	82	82			100	59	54 - 64	
No. 8 (2.36 mm)	1	55	56	61	66			100	42	37 - 47	23 - 49
No. 16 (1.18 mm)	1	35	35	44	51			100	30		
No. 30 (600 µm)	1	30	21	28	38			100	22	18 - 26	
No. 50 (300 µm)	1	21	13	16	26			100	15		
No. 100 (150 µm)	1	14	6	10	17			98	10		
No. 200 (75 µm)	0.5	9.5	3.2	6.5	10.7			97.0	6.4	4.4 - 8.4	2 - 8
Used	30%	20%	19%	10%	20%			1%	100%		
Combined	Dry Sp. Gr.	2.667	2.595	2.611	2.571	2.641		2.380	2.624		
	Apparent Sp. Gr.	2.721	2.674	2.682	2.659	2.683		2.380	2.686		
	Water Absorption (%)	0.7	1.2	1.0	1.3				0.8		
Coarse	Dry Sp. Gr.	2.667	2.625	2.625	2.610	2.641			2.656		
	Apparent Sp. Gr.	2.721	2.694	2.694	2.661	2.683			2.711		
	Water Absorption (%)	0.7	1.0	1.0	0.7				0.7		
Fine	Dry Sp. Gr.	2.667	2.589	2.609	2.563	2.641		2.380	2.602		
	Apparent Sp. Gr.	2.721	2.670	2.680	2.658	2.683		2.380	2.670		
	Water Absorption (%)	0.7	1.2	1.0	1.4				0.8		
Effective Mix Sp. Gr.								2.670			
LA Abrasion (%)	20								20	45 Max.	
Liquid Limit		NL	NL	NL					NL		
Plasticity Index		NP	NP	NP					NP		NP

Note: The RAP specific gravity was back-calculated using an assumed aggregate asphalt absorption.

TABLE II - PHYSICAL PROPERTIES OF AGGREGATE

Test Description and Designation	Composite Results		Mix Design Target
Micro-Deval (CP-L 4211) (%)	4.6		18 Max.
Fractured Face Count (Two Faces) (CP 45) (%)	100.0		90 Min.
Fine Aggregate Angularity (AASHTO T 304)	45.1		45.0 Min.
Flat And Elongated Particles (5:1) (ASTM D 4791) (%)	None		10 Max.
Sand Equivalent (AASHTO T 176 / CP 37) (%)	73		45 Min.
Clay Lumps & Friable Particles (AASHTO T 112) (%)	None		--
Adherent Coating (ASTM D 5711) (%)	0.42		--
Sodium Sulfate Soundness (5 cycles) (AASHTO T 104) (%)	Coarse: 1	Fine: 1	--

Client: Connell Resources, Inc.
Date: March 5, 2019
Project No.: 1195001A-7



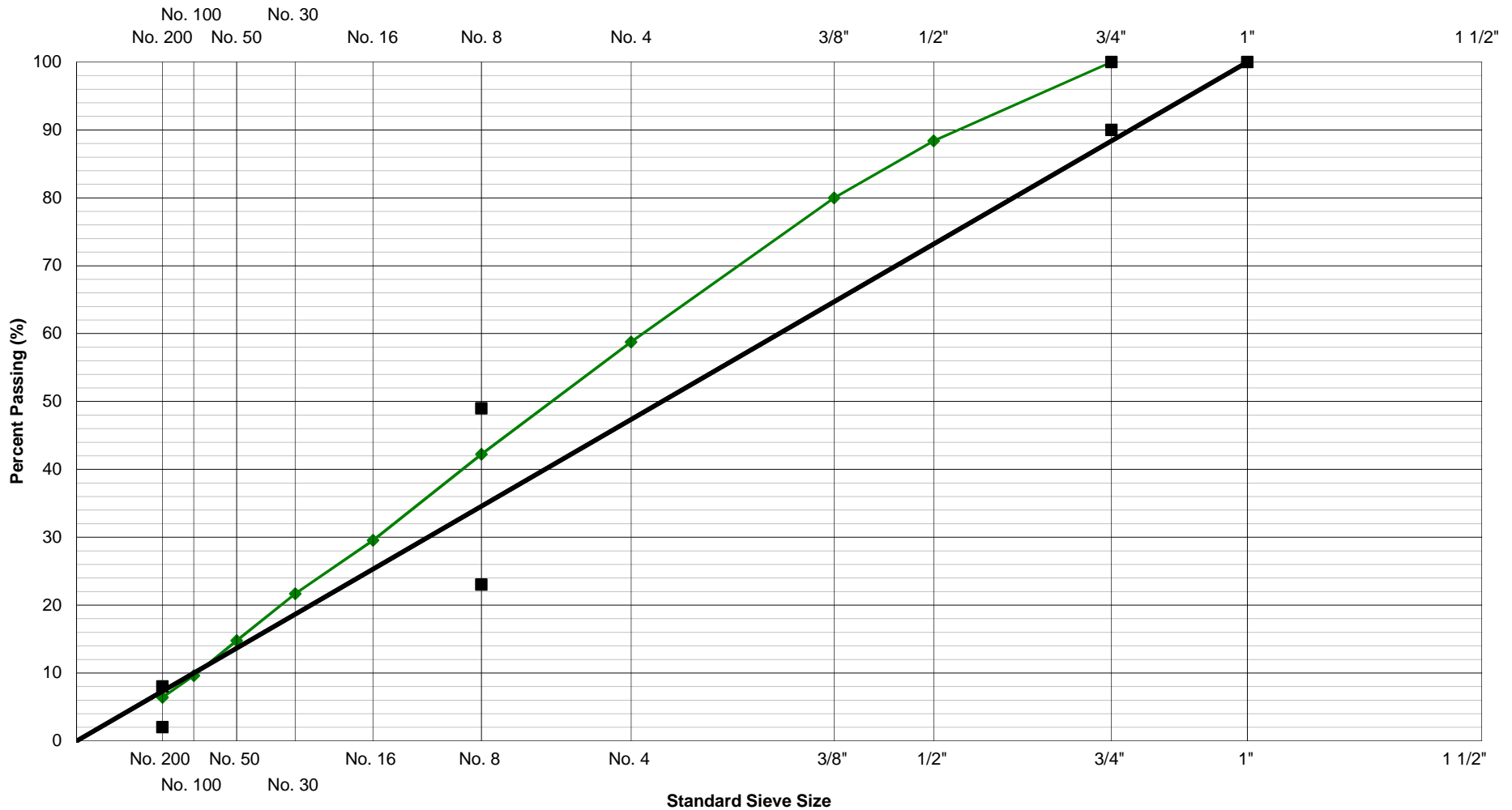
EARTH ENGINEERING CONSULTANTS, LLC

ASPHALTIC CONCRETE MIX DESIGN

Connell Resources, Inc. - Mix No. 22050

Superpave Mix Design: Grading S 75 (Suncor PG 58-28) with Lime

FIGURE I: AGGREGATE GRADATION .45 POWER CURVE



Project: Connell Resources, Inc.
Date: 1195001A-7
Project No.: March 5, 2019



EARTH ENGINEERING CONSULTANTS, LLC
ASPHALTIC CONCRETE MIX DESIGN
 Connell Resources, Inc. - Mix No. 22050
 Superpave Mix Design: Grading S 75 (Suncor PG 58-28) with Lime

TABLE III: SHARP SUPERPAVE PROPERTIES

Asphalt Content (%)		4.3	4.8	5.3	5.8
Maximum Specific Gravity		2.500	2.481	2.462	2.445
Maximum Unit Weight (pcf)		156.0	154.8	153.7	152.5
N _{ini}	Bulk Specific Gravity	2.162	2.180	2.190	2.198
	Voids (%)	13.5	12.1	11.1	10.1
N _{des}	Bulk Specific Gravity	2.337	2.362	2.382	2.396
	Unit Weight (pcf)	145.8	147.4	148.6	149.5
	Height (mm)	66.2	65.3	64.2	63.4
	Voids (%)	6.5	4.8	3.3	2.0
	VMA (%)	14.8	14.3	14.0	14.0
	VFA (%)	56	67	77	86
	Hveem Stability	38	38	37	35
Dust to Asphalt Ratio		1.5	1.3	1.2	1.0

TABLE IV: PROPERTIES AT OPTIMUM ASPHALT CONTENT

Test	Design Properties	Mix Design Target	
Asphalt Content ¹ (%)	5.1	--	
Maximum Specific Gravity	2.470	--	
Maximum Unit Weight (pcf)	154.1	--	
N _{ini}	Bulk Specific Gravity	2.186	
	Voids (%)	11.5	
N _{des}	Bulk Specific Gravity	2.374	
	Unit Weight (pcf)	148.1	
	Height (mm)	64.7	
	Voids (%)	3.9	3.5 - 4.5
	VMA (%)	14.1	13.9 Min.
	VFA (%)	73	65 - 80
	Hveem Stability	37	28 Min.
Dust to Asphalt Ratio	1.2	0.6 - 1.2	
Mixing Temperature	310 °F	310 ±5 °F	
Compaction Temperature	280 °F	280 ±5 °F	

**TABLE V: RESISTANCE TO MOISTURE-INDUCED DAMAGE
 AT OPTIMUM ASPHALT CONTENT (CP-L 5109)**

Tensile Strength Retention (%)	86	80 Min.
Dry Tensile Strength (psi)	56.2	30 Min.
Conditioned Tensile Strength (psi)	48.5	--
Average Specimen Saturation (%)	88	--
Average Specimen Voids (%)	6.3	6.0 - 8.0

¹Asphalt Specific Gravity (Suncor Performance Grade PG 58-28) = 1.032

Project: Connell Resources, Inc.

Project No.: 1195001A-7

Date: March 5, 2019



EARTH ENGINEERING CONSULTANTS, LLC
ASPHALTIC CONCRETE MIX DESIGN
 Connell Resources, Inc. - Mix No. 22050
 Superpave Mix Design: Grading S 75 (Suncor PG 58-28) with Lime

FIGURE II: ASPHALT PROPERTIES VS. ASPHALT CONTENT

