



# The City of **WORCESTER**

Administration & Finance – Purchasing Division  
Christopher J. Gagliastro, MCPPO – Purchasing Director  
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April 14, 2025

To All Bidders:

Subject: **Bid No. 8385-M5 – Resurfacing Granite Street (M25-1)/ DPWP**

## **ADDENDUM NO. 2**

To Whom It May Concern:

With reference to our bid request relative to the above subject, please refer to the changes/modifications/clarifications to the original proposal request.

### **General Bid Clarification:**

1. Please see attached Mix Design for the CIR

### **Questions Received and Answers from the City:**

1. Q: Could you please clarify the Project Limits?  
*A: Project Limits are as follows: Granite Street - 1000' south of Otto Ave to 2300' north of Otto Ave*
2. Q: Does MassDOT prequalification status noted in the CIR specification extend to subcontractors performing the CIR or SFDR?  
*A: Yes. The CIR or SFDR MassDOT prequalification extends to the CIR or SFDR subcontractor.*

Bidders are requested to acknowledge and/or include this addendum with submission. All other terms, conditions and specifications remain unchanged.

Very truly yours,

Stephen R. McDonald  
Assistant Purchasing Director

September 10, 2024

indus  
825 Granite Street  
Braintree, MA 02184



Attn: Matthew Teto, P.E., Quality Control Manager  
RE: Foamed Asphalt Cold in-place Recycling Mix Design  
Worcester, Massachusetts  
AET Report No. P-0030362O

Dear Mr. Teto,

American Engineering Testing, Inc. (AET) is pleased to present the final copy of the Cold In-place Recycling (CIR) Foamed Asphalt Mix Design for the cold recycling project in Worcester, Massachusetts. This cover letter to our mix design report summarizes the mix design information.

## FOAMING CHARACTERIZATION

The asphalt used for the CIR foamed mix designs is a PG 64-22 that was provided by All States Asphalt. We performed foaming tests using our Wirtgen WLB-10S Foamed Asphalt Laboratory on the sample binder in May 2024 in general accordance with the Wirtgen procedure. Results and conclusions from those foaming tests, which are documented in AET Report P-0030362J, are summarized below.

1. The binder met Wirtgen performance limits for expansion ratio (ER) and half-life (HL) for 150°C and 160°C at 1.0%, 1.5%, 2.0%, and 2.5% water contents.
2. The binder did not meet Wirtgen minimum ER and HL for 170°C at 1.0%, 1.5%, 2.0%, and 2.5% water contents.
3. Based on foaming tests, we recommend foaming temperatures of 150°C and 160°C. As we understand that 160°C is your field target for foaming temperature, we have assumed this value for the CIR mix design.
4. We recommend a working range of 1.5% to 2.0% for foaming water. This range is not an "optimum" as defined in the Wirtgen procedure, as the selection of an optimum water content in that procedure presumes a loss in HL performance that we do not observe in our tests.

**550 Cleveland Avenue North | Saint Paul, MN 55114**

**Phone (651) 659-9001 | (800) 972-6364 | Fax (651) 659-1379 | [teamAET.com](http://teamAET.com) | AA/EEO**

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## MIX DESIGN SUMMARY AND MIX PERFORMANCE

AET performed the mix design according to the Paver-Placed In-Place Recycling with Foamed Asphalt (Version 23.3). We understand these provisions are the specification for this project.

1. The material was 100% RAP obtained from cores provided to AET by indus for a 5-inch mix design. The cores were frozen and crushed to provide the material for the mix design. The reclaimed material was processed to resemble a target gradation determined by indus. The final gradation of processed materials is provided in the attached CIR mix design report.
2. The results for the RAP Coating Test (AASHTO T 59 Modified) were "Good."
3. Type I cement (designated as "Cement" in the mix design report) was added to the RAP at an addition rate of 1.0%. This was provided to us by indus and is designated as Lehigh Type I on the container.
4. We performed mix testing at 1.5%, 2.0%, and 2.5% foamed asphalt contents (FAC).
5. Mixes at all three tested FACs exceeded specification requirements for dry indirect tensile strength (ITS) of 45 psi and conditioned ITS of 30 psi. The average conditioned ITS values were 55.4 psi, 62.3 psi, and 63.9 psi at 1.5%, 2.0%, and 2.5% FAC, respectively.
6. The mixes at 1.5%, 2.0%, and 2.5% FAC had tensile strength ratio (TSR) of 87%, 87%, and 81%, respectively.
7. While not required by the Specification, Marshall stability tests were performed on the mixture. The average results were 1683 lb, 2260 lb, and 2065 lb at 1.5%, 2.0%, and 2.5% FAC, respectively.

## OPTIMUM FOAMED ASPHALT CONTENT

The foamed asphalt CIR mix designs at all foamed asphalt contents tested met the performance specification at 1.5%, 2.0%, and 2.5% FAC. It appears that 2.0% FAC provides the best combination of cost and performance FAC due to the following items.

- Marshall stability peaked at 2.0% FAC.
- Although the dry and soaked ITS values increased when FAC was increased to 3.0%, the increase in strength was not significant and the sole benefit of added FAC would be to reduce air voids.

As indicated in our mix design report, your practices may include adjusting the FAC downward to compensate for pavement temperatures (over 100°F), which may affect stability characteristics of the reclaimed mix during construction. Adjust the FAC only if the workability of the reclaimed mix is compromised. Our mix design report provides more detail on these and other adjustments. Please contact us if you have questions or require additional information.

Sincerely,

**American Engineering Testing**



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**Principal Engineer**  
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651-283-2481



Kristen C. Hanson, EIT  
**Engineer II**  
khanson@teamaet.com  
651-328-3078

Attachments:

- a. Foamed Bitumen CIR Mix Design, AET Field Report (4 Pages)
- b. Cover Page, Coring Materials Provided by indus



AET P-00303620

## CIR MIX DESIGN SUMMARY

**Client**

indus

**Attn** Matthew Teto, QC Manager

**AET Contact** Jake Michalowski

**Project**

Paving Project in Town of Worcester

**From**

300' North of Alladin

**To**

800' past #211 Granite Street

<b>Target Foamed Asphalt Content</b>	<b>2.0%</b>
<b>Gal/SY (Assumes 5 in depth)</b>	<b>1.17</b>
<b>Target Moisture Content</b>	<b>2.0%</b>

**Relevant Specification** Paver-Placed In-Place Recycling with Foamed Asphalt (Version 23.3)

### Materials

The asphalt used was manufactured and supplied by All States Asphalt, and was graded as PG 64-22. Bituminous cores were collected from the roadway by indus and provided to AET. AET crushed cores to resemble indus's target gradation. The CIR mix was composed of 100% RAP (produced by crushing frozen cores). AET foamed the asphalt using our Wirtgen Foamed Asphalt Laboratory (Model WLB-10S).

### Mix Preparation

Sampling and testing was performed according to the specification for CIR mix designs, Paver-Placed In-Place Recycling with Foamed Asphalt (Version 23.3), which was provided to AET by indus. CIR specimens were prepared using a gyratory compactor at internal compaction angle of 1.16 degrees and 30 gyrations.

### Comments from Testing

In keeping with the approved scope of work, Marshall stability tests were performed though not required by the Paver-Placed specification. The mixes exceeded spec performance limits at all tested FACs. Tests presume bitumen foaming temperature of 160C and 1.5% baseline water added content.

### Special Notes

Field adjustments to the foamed asphalt content may be required:

- 1) The foamed asphalt content was determined based on the laboratory manufactured gradation. If reclaiming operations cannot be adjusted to create field materials resembling the target gradation, we recommended that the as-produced mixture be tested in the laboratory.
- 2) If the temperature of the existing pavement surface during the reclaiming operation is above 100 deg F, the foamed asphalt content may need to be reduced to maintain workability.
- 3) The "target moisture content" indicated above is moisture added to processed millings in our lab procedure, which assumed "free" or pre-wet water of 2.0%. In the field, this added water would correspond with water added at the milling head.

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AET P-00303620

indus

# FOAMED ASPHALT CIR MIX DESIGN TEST RESULTS

Sample number \_\_\_\_\_ Town of Worcester \_\_\_\_\_

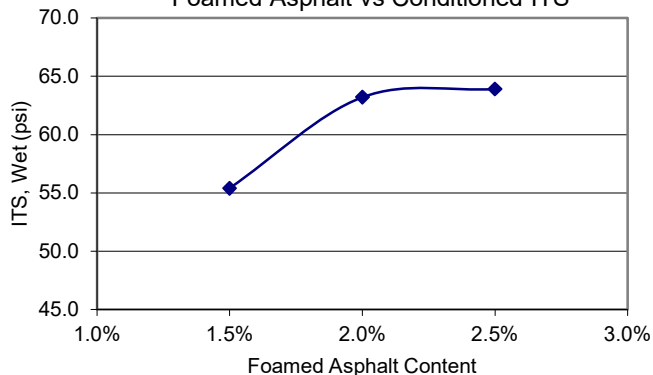
Date \_\_\_\_\_ 9/10/2024 \_\_\_\_\_

Material	RAP	Base	Bitumen	Filler
Location / Source	Road Cores	--	All States Asphalt	Cement
Extracted Binder (%)	--	--	PG 64-22	1.0%
Prewet Water (%)	2.0			

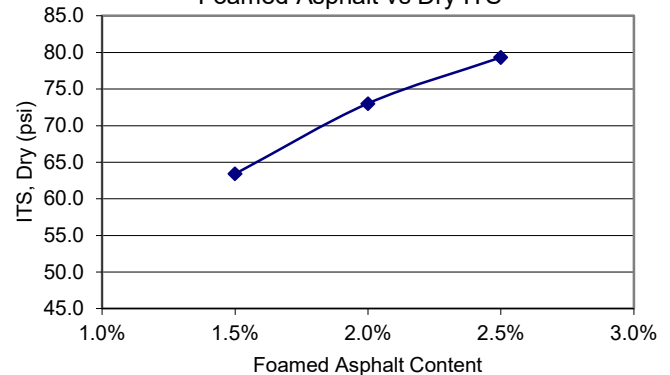
**Foamed asphalt treated material characteristics****Comments**

Foamed asphalt content	1.5%	2.0%	2.5%			
Filler added	1.0%	1.0%	1.0%			
Gradation	Med	Med	Med			Target blend
Bulk Density, lb/ft <sup>3</sup>	132.6	132.4	132.8			
Bulk Spec Grav (Gmb)	2.129	2.126	2.131			
Theo Max Spec Grav (Gmm)	2.420	2.403	2.387			
Air voids (%)	12.0	11.5	10.7			
Marshall Stability, soaked (psi)	--	--	--			n/a
Marshall Stability, dry (psi)	1683	2260	2065			Report
ITS, soaked (psi)	55.4	63.2	63.9			Min 30
ITS, dry (psi)	63.4	73.0	79.3			Min 45
Tensile Strength Ratio	0.87	0.87	0.81			Report
Raveling, Mass Loss (%)	--	--	--			n/a

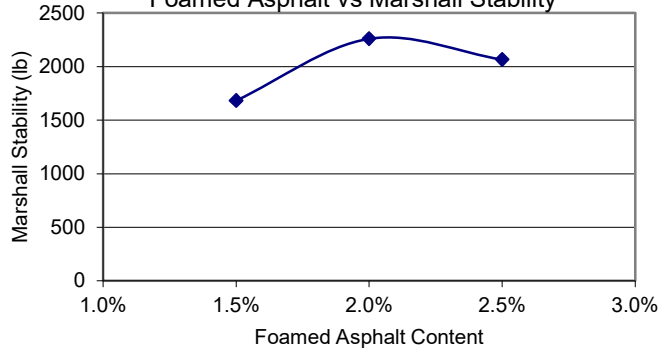
Foamed Asphalt vs Conditioned ITS



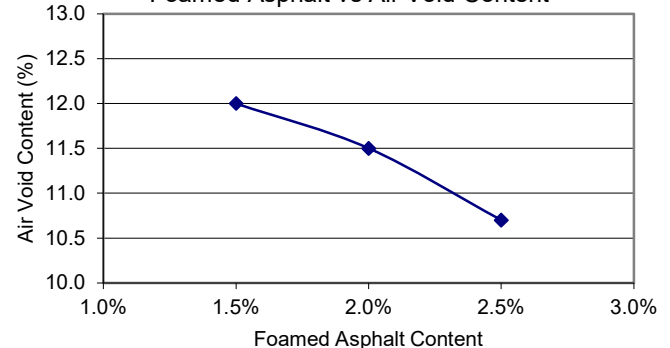
Foamed Asphalt vs Dry ITS



Foamed Asphalt vs Marshall Stability



Foamed Asphalt vs Air Void Content



AET P-00303620

COLD IN-PLACE  
SIEVE ANALYSIS

ASTM D422

Client

indus

Project

Paving Project in Town of Worcester

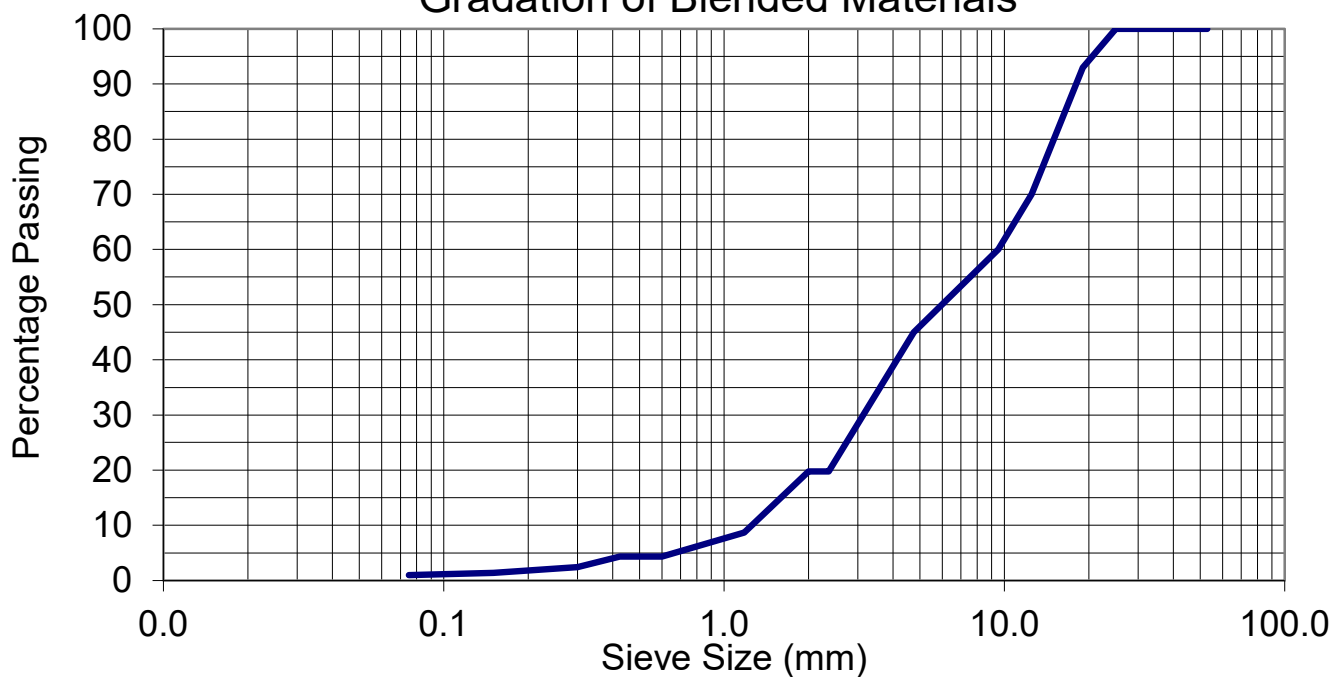
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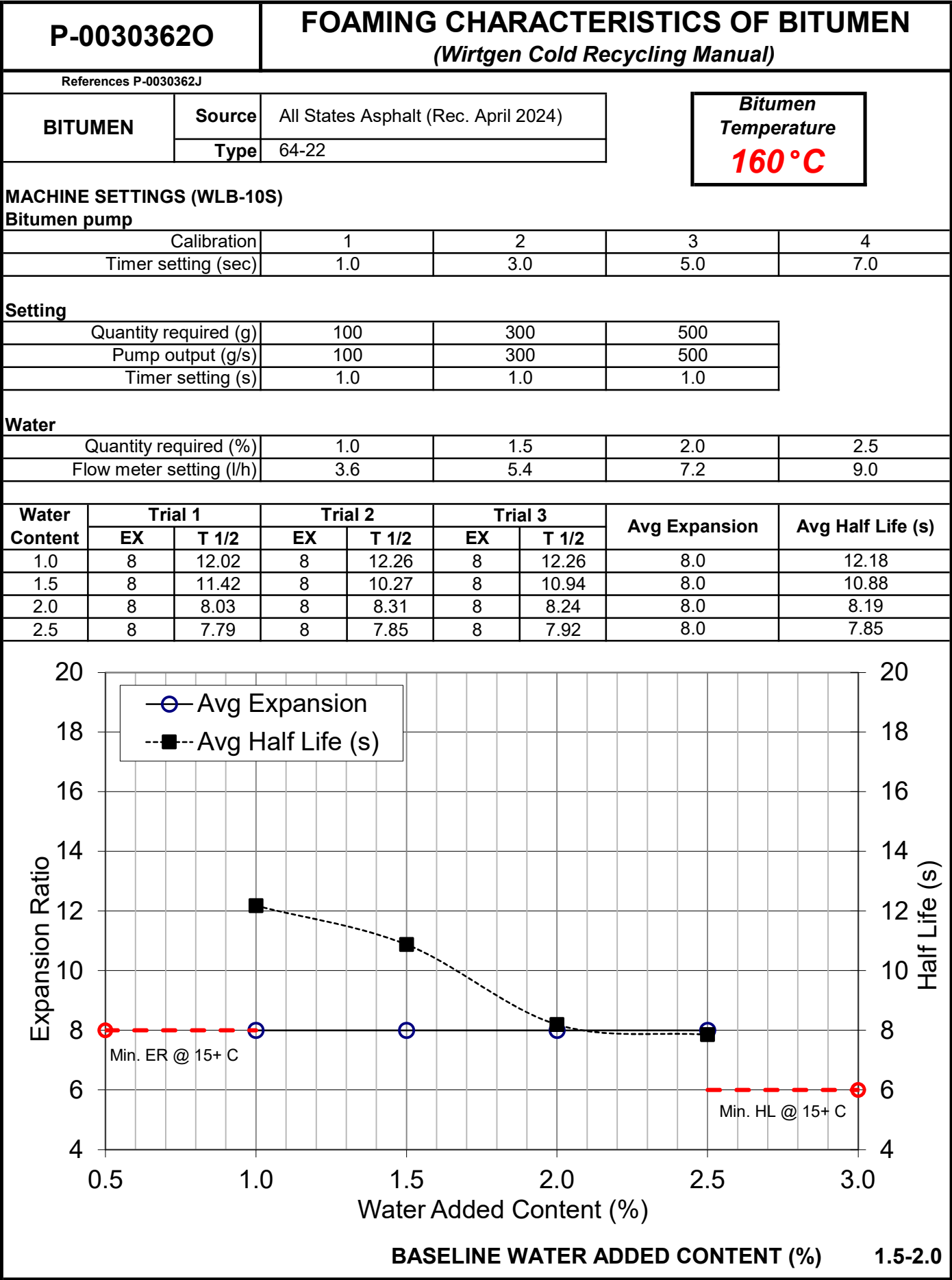
2

3

Location		Millings		Aggregate				Total Percent in Blend
Description		RAP		Cement Filler				
Sample No.		1		2				
Date sampled		--		--				
Percentage in Blend		99		1				100
Mass of sample (g)								
Sieve size		Weight Retained	% Pass.	Weight Retained	% Pass.	Weight Retained	% Pass.	Combined Grading
mm	inch							
53.0	2		100.0		100.0			100.0
37.5	1½		100.0		100.0			100.0
25.0	1		100.0		100.0			100.0
19.0	¾		93.0		100.0			93.1
12.5	½		70.0		100.0			70.3
9.5	⅜		60.0		100.0			60.4
4.75	# 4		45.0		100.0			45.6
2.36	# 8		19.8		100.0			20.6
2.00	# 10		19.8		100.0			20.6
1.18	# 16		8.7		100.0			9.6
0.600	# 30		4.3		100.0			5.3
0.425	# 40		4.3		100.0			5.3
0.300	# 50		2.4		100.0			3.4
0.150	# 100		1.4		100.0			2.4
0.075	# 200		1.0		100.0			2.0

Gradation of Blended Materials





# Mix #14 (5" Mix Design) K-0030362

## CIR Coring for Mix Design Worksheet

Job #

05-24-0275

Owner: City of Worcester Purchasing department

Date:

8/22/24

Road 1: L (ft) W (ft)

Area (sy)

Road 2: L (ft) W (ft)

Area (sy)

Road 3: L (ft) W (ft)

Area (sy)

Road 4: L (ft) W (ft)

Area (sy)

### Road Limits:

Total (sy)

Road #1 From- 300 N of Aladin

To- 800 past # 211 granite st.

Road #2 From-

To-

Road #3 From-

To-

Road #4 From-

To-

Core #

Location:

written description and coordinates

HMA Depth

Base Material

Slope %

Curb Reveal

Road Width

Route 20 1a Side of Middle	Latitude: 42.232447 Longitude: -71.781915	5"	Sand and small stone	1.2	N/A	25'
1b Left of start	42.233279 -71.781219	8"	↓	1.2	↓	↓
1c Right of start	↓	5"	↓	1.2	N/A	↓