

RECEIVED
NOV 06 2015
AIR QUALITY DIV.



Hot Mix Asphalt Emissions Test Report

Prepared for:

Michigan Technological University

Houghton County, Michigan

Michigan Technological University
Dow 812
1400 Townsend Dr.
Houghton, Michigan 49931

Project No. 15-4720.00
October 26, 2015

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Michigan Technological University (MTU) to conduct emissions testing of the exhaust from one hot mix asphalt plant located in Houghton County, Michigan. Testing was conducted for benzene, toluene, ethylbenzene, xylenes, naphthalene, and formaldehyde concentrations and emission rates at the Payne & Dolan, Inc. facility in Hancock, Michigan. The objective of the emissions test program was to provide the Air Quality Division (AQD) of Michigan's Department of Environmental Quality (MDEQ) with emissions data for these compounds during normal operation of the plant, during "hot crumb rubber" operation of the plant, and during "warm crumb rubber" operation of the plant.

The emissions test program was conducted on July 15, 16, and 17, 2015. The overall results of the emission test program are summarized by Table I on the following page.

Table I
Average Test Results Summary
BTEX, Naphthalene, and Formaldehyde Emission Rates
Payne & Dolan
Hancock, Michigan
BTEC Project No. 13-4720.00

Parameter	HMA Average	HCR Average	WCR Average
Sampling Date	7/15/15	7/16/15	7/17/15
HMA Production Rate (tph)	244	220	220
Exhaust Gas Flowrate (scfm)	31,610	29,559	31,471
Exhaust Gas Flowrate (dscfm)	20,205	19,859	20,693
Formaldehyde Concentration (ppmv)	1.4	1.6	0.9
Benzene Concentration (ppmvd)	< 0.065	< 0.096	< 0.065
Toluene Concentration (ppmvd)	< 0.047	0.245	0.199
Ethylbenzene Concentration (ppmvd)	< 0.074	< 0.131	< 0.150
m-Xylene Concentration (ppmvd)	< 0.034	1.218	1.003
p-Xylene Concentration (ppmvd)	< 0.037	< 0.059	< 0.035
o-Xylene Concentration (ppmvd)	< 0.038	< 0.037	0.036
Naphthalene Concentration (ppmvd)	0.066	< 0.053	0.029
Formaldehyde Emission Rate (lbs/hr)	0.21	0.22	0.13
Benzene Emission Rate (lbs/hr)	< 0.02	< 0.02	< 0.02
Toluene Emission Rate (lbs/hr)	< 0.01	0.07	0.06
Ethylbenzene Emission Rate (lbs/hr)	< 0.02	< 0.04	< 0.05
m-Xylene Emission Rate (lbs/hr)	< 0.01	0.39	0.34
p-Xylene Emission Rate (lbs/hr)	< 0.01	< 0.02	< 0.01
o-Xylene Emission Rate (lbs/hr)	< 0.01	< 0.01	0.01
Naphthalene Emission Rate (lbs/hr)	0.03	< 0.02	0.01
Formaldehyde Emission Rate (lbs/1,000 tons)	0.85	0.99	0.60
Benzene Emission Rate (lbs/1,000 tons)	< 0.07	< 0.10	< 0.07
Toluene Emission Rate (lbs/1,000 tons)	< 0.06	0.32	0.27
Ethylbenzene Emission Rate (lbs/1,000 tons)	< 0.10	< 0.19	< 0.23
m-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	1.80	1.56
p-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	< 0.09	< 0.05
o-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	< 0.06	0.06
Naphthalene Emission Rate (lbs/1,000 tons)	0.11	< 0.10	0.05

HMA = Hot Mix Asphalt
HCR = Hot Crumb Rubber Asphalt Mix
WCR = Warm Crumb Rubber Asphalt Mix

TABLE OF CONTENTS

1. INTRODUCTION	1
1.A IDENTIFICATION, LOCATION, AND DATES OF TEST.....	1
1.B PURPOSE OF TESTING	1
1.C SOURCE DESCRIPTION	1
1.D TEST PROGRAM CONTACTS.....	2
2. SUMMARY OF RESULTS.....	2
2.A OPERATING DATA	2
2.B APPLICABLE PERMIT	2
2.C RESULTS	3
3. SOURCE DESCRIPTION.....	3
3.A PROCESS DESCRIPTION.....	3
3.B PROCESS FLOW DIAGRAM.....	3
3.C RAW AND FINISHED MATERIALS.....	3
3.D PROCESS CAPACITY.....	3
3.E PROCESS INSTRUMENTATION.....	3
4. SAMPLING AND ANALYTICAL PROCEDURES.....	3
4.A SAMPLING TRAIN AND FIELD PROCEDURES.....	3
4.B RECOVERY AND ANALYTICAL PROCEDURES	4
4.C SAMPLING PORTS	4
4.D TRAVERSE POINTS.....	4
5. TEST RESULTS AND DISCUSSION.....	4
5.A RESULTS TABULATION.....	5
5.B DISCUSSION OF RESULTS.....	5
5.C SAMPLING PROCEDURE VARIATIONS.....	5
5.D PROCESS OR CONTROL DEVICE UPSETS.....	5
5.E CONTROL DEVICE MAINTENANCE	5
5.F RE-TEST	5
5.G AUDIT SAMPLE ANALYSES.....	5
5.H CALIBRATION SHEETS.....	5
5.I SAMPLE CALCULATIONS	5
5.J FIELD DATA SHEETS	6
5.K LABORATORY DATA.....	6

TABLE OF CONTENTS (continued)

SUMMARY TABLES

Table 1	Test Personnel Summary
Table 2	Hot Mix Asphalt Emission Rates
Table 3	Hot Mix Asphalt with Hot Crumb Rubber Emission Rates
Table 4	Hot Mix Asphalt with Warm Crumb Rubber Emission Rates
Table 5	Overall Test Results Summary

APPENDIX

Appendix A	Process Data
Appendix B	Prism Analytical Technologies Test Reports
Appendix C	Equipment Calibration Documents
Appendix D	Example Calculations
Appendix E	Field Documents

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Michigan Technological University (MTU) to conduct emissions testing of the exhaust from one hot mix asphalt plant located in Houghton County, Michigan. Testing was conducted for benzene, toluene, ethylbenzene, xylenes, naphthalene, and formaldehyde concentrations and emission rates at the Payne & Dolan, Inc. facility in Hancock, Michigan. The objective of the emissions test program was to provide the Air Quality Division (AQD) of Michigan's Department of Environmental Quality (MDEQ) with emissions data for these compounds during normal operation of the plant, during "hot crumb rubber" operation of the plant, and during "warm crumb rubber" operation of the plant.

The emissions test program was conducted on July 15, 16, and 17, 2015. The purpose of this report is to document the results of the test program.

AQD has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

Testing was conducted at the Payne & Dolan facility located at 19320 East Kiiskila Road in Hancock, Michigan.

1.b Purpose of Testing

Testing was conducted for benzene, toluene, ethylbenzene, xylenes, naphthalene, and formaldehyde concentrations and emission rates at the Payne & Dolan, Inc. facility in Hancock, Michigan. The objective of the emissions test program was to provide AQD with emissions data for these compounds during normal operation of the plant, during "hot crumb rubber" operation of the plant, and during "warm crumb rubber" operation of the plant.

1.c Source Description

The hot mix asphalt plant exhaust was tested with the plant producing regular hot mix asphalt, then tested with the plant producing hot mix asphalt with crumb rubber added, and then tested with the plant producing warm mix asphalt with crumb rubber added. In each case the feed consisted of sand and gravel igneous aggregates with bituminous binder.

Mix design sheets for each product are included in Appendix A. The production rate for hot mix asphalt operation was approximately 244 tons per hour. The production rate for hot mix asphalt with crumb rubber operation was approximately 220 tons per hour. The

production rate for warm mix asphalt with crumb rubber operation was approximately 220 tons per hour.

1.d Test Program Contacts

The contacts for the source and test report are:

Mr. David L. Perram
Michigan Technological University
Adjunct Lecturer/Research Scientist II
Civil and Environmental Engineering
Dow 812
1400 Townsend Dr.
Houghton, Michigan 49931

Ms. Lori Myott
Project Manager
NTH Consultants, Ltd.
608 South Washington Avenue
Lansing, Michigan 48933

Mr. Barry Boulianne
Senior Project Manager
BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073

Names and affiliations for personnel who were present during the testing program are summarized by Table 1.

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions compliance test program.

2.a Operating Data

Operating data for the emissions test program is included on the field data sheets included in Appendix A.

2.b Applicable Permit

The purpose of the emissions test program was to provide emissions data for the three product types to AQD.

2.c Results

The overall results of the emission test program are summarized by Tables 2 through 5 (see Section 5.a).

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

The hot mix asphalt plant exhaust was tested with the plant producing regular hot mix asphalt, then tested with the plant producing hot mix asphalt with crumb rubber added, and then tested with the plant producing warm mix asphalt with crumb rubber added. In each case the feed consisted of sand and gravel igneous aggregates with bituminous binder.

3.b Process Flow Diagram

Due to the simplicity of the process, a process flow diagram is not provided.

3.c Raw and Finished Materials

Raw materials include sand and gravel igneous aggregates with bituminous binder. The finished product is hot mix asphalt.

3.d Process Capacity

The maximum production rate of the hot mix asphalt plant is approximately 275 tons per hour.

3.e Process Instrumentation

Process data is included in Appendix A.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

4.a Sampling Train and Field Procedures

The pollutants measured during this emissions test program were benzene, toluene, ethylbenzene, xylenes, naphthalene, and formaldehyde. In addition, concentrations of oxygen (O₂), carbon dioxide (CO₂), and moisture were measured during the emissions test program.

Sampling and analysis procedures will follow the methodologies of the following emissions test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 1 - "Sample and Velocity Traverses for Stationary Sources"
- Method 2 - "Determination of Stack Gas Velocity and Volumetric Flowrate"
- Method 3 - "Determination of Molecular Weight of Dry Stack Gas"(Fyrite)
- Method 18 - "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography"
- Method 320 - "Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy"

Exhaust gas flowrates were measured using an "S-type" pitot tube and thermocouple assembly along with a manometer to measure exhaust gas velocity pressure and temperature. O₂ concentrations for exhaust gas molecular weight were determined using a Fyrite® combustion gas analyzer with a squeeze bulb. Exhaust gas CO₂ and moisture content were measured using Method 320.

Benzene, toluene, ethylbenzene, o-xylene, m-xylene, p-xylene, and naphthalene concentrations were measured using Method 18 and formaldehyde emissions were measured using Method 320. All Method 18 and 320 analysis was performed by Prism Analytical Technologies of Mount Pleasant, Michigan. Summaries of the sampling and analysis methodologies are summarized in the Prism Analytical Technologies reports included in Appendix B.

4.b Recovery and Analytical Procedures

Summaries of the recovery and analysis methodologies are summarized in the Prism Analytical Technologies reports included in Appendix B.

4.c Sampling Ports

Five sampling ports are located in the rectangular exhaust stack.

4.d Traverse Points

For flow traverses, fifteen points were used with three points across each of the test port locations.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The overall results of the emissions test program are summarized by Table 5. Detailed results for the emissions test program are summarized by Tables 2 through 4.

5.b Discussion of Results

The purpose of the emissions test program was to provide emissions data for comparison to baseline hot mix asphalt emissions. A comparison of the emissions test results is provided in Table 5.

5.c Sampling Procedure Variations

Due to the high moisture content of the sample collected for Run 1 during the regular HMA production, test results were not able to be quality assured and, consequently, no concentration or emission rate test results are reported for this test run. In addition, production of WCR asphalt was halted before BTEC could conduct the third exhaust gas flowrate test run. Consequently, the average of the exhaust gas flowrate measured during Runs 1 and 2 was used to calculate emission rates for Run 3.

5.d Process or Control Device Upsets

No upset conditions occurred during testing.

5.e Control Device Maintenance

Only routine control equipment maintenance was performed prior to the emissions test program.

5.f Re-Test

The emissions test program was not a re-test.

5.g Audit Sample Analyses

No audit samples were collected as part of the test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix C.

5.i Sample Calculations

Sample calculations are provided in Appendix D.

5.j Field Data Sheets

Field documents relevant to the emissions test program are presented in Appendix E.

5.k Laboratory Data

Laboratory data for the emissions test program is included in the Prism Analytical Technologies reports included in Appendix B.

TABLES

**Table 1
Test Personnel**

Name and Title	Affiliation	Telephone
David L Perram Adjunct Lecturer/Research Scientist II	Michigan Technological University Civil and Env. Engineering Dow 812 1400 Townsend Dr. Houghton, MI 49931	(906) 487-2713
Ms. Lindsey Wells FTIR Application Specialist	Prism Analytical Technologies 2625 Denison Drive Mount Pleasant, MI 48858	(989) 772-5088
Mr. Ken Lievense Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Diven Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Tom Gasloli Environmental Quality Analyst	MDEQ Air Quality Division	(517) 284-6778

Table 2
Hot Mix Asphalt Production
BTEX, Naphthalene, and Formaldehyde Emission Rates
Payne & Dolan
Hancock, Michigan
BTEC Project No. 13-4720.00

Parameter	Run 1*	Run 2	Run 3	Run 4	Run 5	Run 6	Average
Sampling Date	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	
Sampling Time		12:08 to 12:15 & 12:35 to 13:00	13:12 to 13:52	14:02 to 14:24 & 14:54 to 15:12	15:22 to 16:02	16:31 to 16:41 & 17:25 to 17:55	
HMA Production Rate (tph)		244	244	244	245	243	244.0
Exhaust Gas Flowrate (scfm)	31,286	30,693	29,600	34,778	31,177	32,127	31,610
Exhaust Gas Flowrate (dscfm)	19,804	19,398	18,559	22,189	20,234	21,044	20,205
Formaldehyde Concentration (ppmv)		1.5	1.4	1.4	1.4	1.3	1.4
Benzene Concentration (ppmvd)	<	0.043	< 0.044	0.040	0.151	0.049	< 0.065
Toluene Concentration (ppmvd)	<	0.044	< 0.047	0.052	0.049	< 0.041	< 0.047
Ethylbenzene Concentration (ppmvd)		0.142	0.093	0.049	< 0.039	0.049	< 0.074
m-Xylene Concentration (ppmvd)	<	0.034	< 0.036	< 0.032	< 0.037	0.032	< 0.034
p-Xylene Concentration (ppmvd)	<	0.035	< 0.037	0.041	< 0.038	< 0.032	< 0.037
o-Xylene Concentration (ppmvd)	<	0.038	< 0.040	0.035	< 0.041	< 0.034	< 0.038
Naphthalene Concentration (ppmvd)		0.085	0.074	0.085	0.046	0.039	0.066
Formaldehyde Emission Rate (lbs/hr)		0.22	0.19	0.23	0.20	0.20	0.21
Benzene Emission Rate (lbs/hr)	<	0.01	< 0.01	0.01	0.04	0.01	< 0.02
Toluene Emission Rate (lbs/hr)	<	0.01	< 0.01	0.02	0.01	< 0.01	< 0.01
Ethylbenzene Emission Rate (lbs/hr)		0.05	0.03	0.02	< 0.01	0.02	< 0.02
m-Xylene Emission Rate (lbs/hr)	<	0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01
p-Xylene Emission Rate (lbs/hr)	<	0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01
o-Xylene Emission Rate (lbs/hr)	<	0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
Naphthalene Emission Rate (lbs/hr)		0.03	0.03	0.04	0.02	0.02	0.03
Formaldehyde Emission Rate (lbs/1,000 tons)		0.88	0.79	0.93	0.83	0.80	0.85
Benzene Emission Rate (lbs/1,000 tons)	<	0.04	< 0.04	0.04	0.15	0.05	< 0.07
Toluene Emission Rate (lbs/1,000 tons)	<	0.05	< 0.05	0.07	0.06	< 0.05	< 0.06
Ethylbenzene Emission Rate (lbs/1,000 tons)		0.19	0.12	0.07	< 0.05	0.07	< 0.10
m-Xylene Emission Rate (lbs/1,000 tons)	<	0.04	< 0.05	< 0.05	< 0.05	0.05	< 0.05
p-Xylene Emission Rate (lbs/1,000 tons)	<	0.05	< 0.05	0.06	< 0.05	< 0.05	< 0.05
o-Xylene Emission Rate (lbs/1,000 tons)	<	0.05	< 0.05	0.05	< 0.06	< 0.05	< 0.05
Naphthalene Emission Rate (lbs/1,000 tons)		0.13	0.11	0.15	0.08	0.07	0.11

*Laboratory Data for Run 1 was not able to be validated.

Table 3
Hot Crumb Rubber Asphalt Production
BTEX, Naphthalene, and Formaldehyde Emission Rates
Payne & Dolan
Hancock, Michigan
BTEC Project No. 13-4720.00

Parameter	Run 1	Run 2	Run 3	Run 4	Run 5	Average
Sampling Date	7/16/2015	7/16/2015	7/16/2015	7/16/2015	7/16/2015	
Sampling Time	9:24 to 10:06	10:16 to 10:28 & 10:56 to 11:24	11:37 to 12:17	12:26 to 12:30 & 13:09 to 13:45	13:56 to 14:26 & 15:05 to 15:15	
HMA Production Rate (tph)	219	220	220	219	220	219.6
Exhaust Gas Flowrate (scfm)	29,687	32,242	27,191	29,454	29,222	29,559
Exhaust Gas Flowrate (dscfm)	20,158	21,860	18,435	19,498	19,345	19,859
Formaldehyde Concentration (ppmv)	1.6	1.4	1.6	1.6	1.7	1.6
Benzene Concentration (ppmvd)	0.110	< 0.080	0.094	0.076	0.119	< 0.096
Toluene Concentration (ppmvd)	0.259	0.189	0.164	0.237	0.378	0.245
Ethylbenzene Concentration (ppmvd)	0.208	0.065	< 0.046	0.109	0.225	< 0.131
m-Xylene Concentration (ppmvd)	1.448	0.529	1.343	1.366	1.405	1.218
p-Xylene Concentration (ppmvd)	0.088	< 0.052	< 0.036	< 0.080	< 0.038	< 0.059
o-Xylene Concentration (ppmvd)	< 0.034	< 0.049	< 0.035	< 0.031	< 0.036	< 0.037
Naphthalene Concentration (ppmvd)	0.088	< 0.020	0.050	0.050	0.059	< 0.053
Formaldehyde Emission Rate (lbs/hr)	0.22	0.21	0.20	0.22	0.23	0.22
Benzene Emission Rate (lbs/hr)	0.03	< 0.02	0.02	0.02	0.03	< 0.02
Toluene Emission Rate (lbs/hr)	0.07	0.06	0.04	0.07	0.10	0.07
Ethylbenzene Emission Rate (lbs/hr)	0.07	0.02	< 0.01	0.04	0.07	< 0.04
m-Xylene Emission Rate (lbs/hr)	0.48	0.19	0.41	0.44	0.45	0.39
p-Xylene Emission Rate (lbs/hr)	0.03	< 0.02	< 0.01	< 0.03	< 0.01	< 0.02
o-Xylene Emission Rate (lbs/hr)	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
Naphthalene Emission Rate (lbs/hr)	0.04	< 0.01	0.02	0.02	0.02	< 0.02
Formaldehyde Emission Rate (lbs/1,000 tons)	1.01	0.96	0.92	1.01	1.06	0.99
Benzene Emission Rate (lbs/1,000 tons)	0.12	< 0.10	0.10	0.08	0.13	< 0.10
Toluene Emission Rate (lbs/1,000 tons)	0.34	0.27	0.20	0.30	0.48	0.32
Ethylbenzene Emission Rate (lbs/1,000 tons)	0.32	0.11	< 0.06	0.16	0.33	< 0.19
m-Xylene Emission Rate (lbs/1,000 tons)	2.20	0.87	1.86	2.01	2.04	1.80
p-Xylene Emission Rate (lbs/1,000 tons)	0.13	< 0.09	< 0.05	< 0.12	< 0.06	< 0.09
o-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	< 0.08	< 0.05	< 0.05	< 0.05	< 0.06
Naphthalene Emission Rate (lbs/1,000 tons)	0.16	< 0.04	0.08	0.09	0.10	< 0.10

Table 4
Warm Crumb Rubber Asphalt Production
BTEX, Naphthalene, and Formaldehyde Emission Rates
Payne & Dolan
Hancock, Michigan
BTEC Project No. 13-4720.00

Parameter	Run 1	Run 2	Run 3*	Average
Sampling Date	7/17/2015	7/17/2015	7/17/2015	
Sampling Time	11:40 to 12:20	12:27 to 12:49 & 13:52 to 14:10	14:15 to 14:55	
HMA Production Rate (tph)	222	219	220	220.3
Exhaust Gas Flowrate (scfm)	31,296	31,646	31,471	31,471
Exhaust Gas Flowrate (dscfm)	20,468	20,918	20,693	20,693
Formaldehyde Concentration (ppmv)	0.9	0.9	0.9	0.9
Benzene Concentration (ppmvd)	< 0.050	< 0.050	0.096	< 0.065
Toluene Concentration (ppmvd)	0.214	0.195	0.189	0.199
Ethylbenzene Concentration (ppmvd)	0.375	< 0.037	< 0.037	< 0.150
m-Xylene Concentration (ppmvd)	1.009	1.059	0.940	1.003
p-Xylene Concentration (ppmvd)	< 0.035	< 0.035	< 0.034	< 0.035
o-Xylene Concentration (ppmvd)	< 0.037	< 0.037	< 0.035	0.036
Naphthalene Concentration (ppmvd)	0.029	< 0.029	< 0.029	0.029
Formaldehyde Emission Rate (lbs/hr)	0.13	0.13	0.13	0.13
Benzene Emission Rate (lbs/hr)	< 0.01	< 0.01	0.02	< 0.02
Toluene Emission Rate (lbs/hr)	0.06	0.06	0.06	0.06
Ethylbenzene Emission Rate (lbs/hr)	0.13	< 0.01	< 0.01	< 0.05
m-Xylene Emission Rate (lbs/hr)	0.34	0.37	0.32	0.34
p-Xylene Emission Rate (lbs/hr)	< 0.01	< 0.01	< 0.01	< 0.01
o-Xylene Emission Rate (lbs/hr)	< 0.01	< 0.01	< 0.01	0.01
Naphthalene Emission Rate (lbs/hr)	0.01	< 0.01	< 0.01	0.01
Formaldehyde Emission Rate (lbs/1,000 tons)	0.59	0.61	0.60	0.60
Benzene Emission Rate (lbs/1,000 tons)	< 0.06	< 0.06	0.11	< 0.07
Toluene Emission Rate (lbs/1,000 tons)	0.28	0.27	0.25	0.27
Ethylbenzene Emission Rate (lbs/1,000 tons)	0.57	< 0.06	< 0.06	< 0.23
m-Xylene Emission Rate (lbs/1,000 tons)	1.54	1.67	1.46	1.56
p-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	< 0.06	< 0.05	< 0.05
o-Xylene Emission Rate (lbs/1,000 tons)	< 0.06	< 0.06	< 0.05	0.06
Naphthalene Emission Rate (lbs/1,000 tons)	0.05	< 0.06	< 0.05	0.05

*An exhaust gas flowrate measurement was not conducted for Run 3 because plant production stopped. The exhaust gas flowrates listed for Run 3 are the average of the values for Runs 1 and 2.

Table 5
Average Test Results Summary
BTEX, Naphthalene, and Formaldehyde Emission Rates
Payne & Dolan
Hancock, Michigan
BTEC Project No. 13-4720.00

Parameter	HMA Average	HCR Average	WCR Average
Sampling Date	7/15/15	7/16/15	7/17/15
HMA Production Rate (tph)	244	220	220
Exhaust Gas Flowrate (scfm)	31,610	29,559	31,471
Exhaust Gas Flowrate (dscfm)	20,205	19,859	20,693
Formaldehyde Concentration (ppmv)	1.4	1.6	0.9
Benzene Concentration (ppmvd)	< 0.065	< 0.096	< 0.065
Toluene Concentration (ppmvd)	< 0.047	0.245	0.199
Ethylbenzene Concentration (ppmvd)	< 0.074	< 0.131	< 0.150
m-Xylene Concentration (ppmvd)	< 0.034	1.218	1.003
p-Xylene Concentration (ppmvd)	< 0.037	< 0.059	< 0.035
o-Xylene Concentration (ppmvd)	< 0.038	< 0.037	0.036
Naphthalene Concentration (ppmvd)	0.066	< 0.053	0.029
Formaldehyde Emission Rate (lbs/hr)	0.21	0.22	0.13
Benzene Emission Rate (lbs/hr)	< 0.02	< 0.02	< 0.02
Toluene Emission Rate (lbs/hr)	< 0.01	0.07	0.06
Ethylbenzene Emission Rate (lbs/hr)	< 0.02	< 0.04	< 0.05
m-Xylene Emission Rate (lbs/hr)	< 0.01	0.39	0.34
p-Xylene Emission Rate (lbs/hr)	< 0.01	< 0.02	< 0.01
o-Xylene Emission Rate (lbs/hr)	< 0.01	< 0.01	0.01
Naphthalene Emission Rate (lbs/hr)	0.03	< 0.02	0.01
Formaldehyde Emission Rate (lbs/1,000 tons)	0.85	0.99	0.60
Benzene Emission Rate (lbs/1,000 tons)	< 0.07	< 0.10	< 0.07
Toluene Emission Rate (lbs/1,000 tons)	< 0.06	0.32	0.27
Ethylbenzene Emission Rate (lbs/1,000 tons)	< 0.10	< 0.19	< 0.23
m-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	1.80	1.56
p-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	< 0.09	< 0.05
o-Xylene Emission Rate (lbs/1,000 tons)	< 0.05	< 0.06	0.06
Naphthalene Emission Rate (lbs/1,000 tons)	0.11	< 0.10	0.05

HMA = Hot Mix Asphalt

HCR = Hot Crumb Rubber Asphalt Mix

WCR = Warm Crumb Rubber Asphalt Mix

APPENDIX A