

JOINT TRANSPORTATION RESEARCH PROGRAM

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Central HMA Acceptance Lab Process Improvement Implementation Plan Project



Ted W. Boehm

Jim Handy

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AUTHORS

Ted W. Boehm

Advanced Manufacturing Consultant
Technical Assistance Program
Purdue University
Principle Investigator

Jim Handy

Senior Industry Advisor
Technical Assistance Program
Purdue University
(317)-275-6810
tapmep@purdue.edu
Corresponding Author

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16. Abstract The Indiana Department of Transportation (INDOT) Central Hot Mix Asphalt (HMA) Acceptance Lab was opened on March 29, 2018 at the Office of Materials Management (OMM) facility in Indianapolis. The state-of-the-art lab conducts acceptance testing on HMA samples from INDOT's Crawfordsville and Greenfield districts, as well as testing of appeals samples from the other four INDOT districts. Each HMA sample undergoes multiple sequences acceptance testing processes. In 2019, project SPR-4353 "Central HMA Acceptance Lab Process Improvement Project" was conducted with the goal to improve organization, flow of work and efficiency in the central region HMA Acceptance Lab for all tests done, and provide implementation leading to the reduction of turnaround time from six days to four days. This project follows key recommended actions from SPR-4353 to implementation.					
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EXECUTIVE SUMMARY

Introduction

The Indiana Department of Transportation (INDOT) Central Hot Mix Asphalt (HMA) Acceptance Lab was opened on March 29, 2018 at the Office of Materials Management (OMM) facility in Indianapolis. The state-of-the-art lab conducts acceptance testing on HMA samples from INDOT's Crawfordsville and Greenfield districts, as well as appeals samples from the other four INDOT districts. Each HMA sample undergoes multiple sequences of acceptance testing processes. In 2019, project SPR-4353 *Central HMA Acceptance Lab Process Improvement Project* was conducted with the goal of improving organization, workflow, and efficiency in the central region HMA Acceptance Lab, and suggestion implementations that reduce the turnaround time for tests from six days to four days. This project implements the key recommended actions from SPR-4353.

Findings

As reported in SPR-4353, four fundamental issues inhibit the performance of the HMA Acceptance Lab Turnaround Time.

1. Lack of a structured sample scheduling system based on capacity.
2. Lack of capacity to meet peak demand.
3. Not focusing on maximizing throughput at the bottleneck extraction operation.
4. Not getting results reported on the day the testing is completed.

While numerous actions were recommended, and some piloted, those with the highest impact were targeted to address four fundamental issues. In association with those recommended actions, the implementation objectives of this project were to do the following:

1. Establish a structured scheduling method.
 - a. A specific schedule is assigned to each test for each sample.

- b. The schedule is based on the date planned for bottleneck Extraction operation.
 - c. Dates are scheduled for Extraction based on the available capacity at Extraction.
 - d. All other processes/tests are scheduled based on the planned Extraction date.
 - e. Do not load schedule to 100% of capacity, allowing time for reruns, appeals, etc.
2. Establish a Work Order ("Test Order") routing system to communicate scheduled dates and to provide visual identification and control of the flow samples in the lab.
3. Use the Resource vs. Demand model to facilitate/trigger planning of overtime.
4. Adjust/stagger schedules of lab management/administration staff to provide resources at end-of-shift for reporting test results.
5. Establish and communicate a performance metric for schedule compliance (i.e., compliance to the specific schedules for each sample).

All of these implementation objectives have been achieved for this project.

Implementation

Achievement of the implementation objectives was accomplished primarily via implementation of the following Excel-based tools:

1. A new "HMA Master Schedule" file, a macro-enabled Excel tool, linked with, and importing data from, the Districts' "HMA Work Book" files.
2. A revised "Lab Work Sheet" file, linked with, and importing data from, the "HMA Master Schedule" file.

The implementation of these tools provided additional benefits by dramatically reducing the required manual data entry time for entering samples into the HMA Lab process, and by providing the ability to display real-time daily schedule and completion information on large television monitors in the HMA Lab.

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1. INTRODUCTION

The Indiana Department of Transportation (INDOT) Central Hot Mix Asphalt (HMA) Acceptance Lab was opened on March 29, 2018 at the Office of Materials Management (OMM) facility in Indianapolis. The state-of-the-art lab conducts acceptance testing on HMA samples from INDOT's Crawfordsville and Greenfield districts, as well as testing of appeals samples from the other four INDOT districts. Each HMA sample undergoes multiple sequences acceptance testing processes. INDOT's standard metric is for these tests to be completed and reported in six days. Overall average performance in 2018 met this target (4.66 days for Crawfordsville, 4.99 days for Greenfield), however, turnaround time exceeding this target during months of peak demand.

In February 2019, JTRP Project SPR-4353 was initiated, with the goal of improving the organization, flow of work and efficiency in the central region HMA Acceptance Lab for all tests done, with implementation leading to reduction of turnaround time from six days to four days. This project was completed in August 2019.

SPR-4353 identified four fundamental issues inhibiting the performance of the HMA Acceptance Lab Turnaround Time.

1. Lack of structured sample scheduling system based on capacity.
2. Lack of capacity to meet peak demand.
3. Not focusing on maximizing throughput at the bottleneck Extraction operation.
4. Not getting results reported on the day the testing is completed.

While numerous actions were recommended, and some piloted, those with the highest impact on these four fundamental issues were identified. The purpose of this implementation plan project was to further develop and pilot these actions, leading to implementation during the 2020 summer paving season.

Specifically, the implementation objectives for this project were the following:

1. Establish a structured scheduling method.
 - a. A specific schedule is assigned to each test for each sample.
 - b. The schedule is based on the date planned for bottleneck Extraction operation.
 - c. Dates are scheduled for Extraction based on the available capacity at Extraction.
 - d. All other processes/tests are scheduled based on the planned Extraction date.
 - e. Do not load schedule to 100% of capacity, allowing time for reruns, appeals, etc.
2. Establish a Work Order ("Test Order") routing system to communicate scheduled dates and to provide visual identification and control of the flow samples in the lab.
3. Use the Resource vs. Demand model to facilitate/trigger planning of overtime.
4. Adjust/stagger schedules of lab management/administration staff to provide resources at end-of-shift for reporting test results.
5. Establish and communicate a performance metric for schedule compliance (i.e., compliance to the specific schedules for each sample).

2. RESULTS/ACTIVITY SUMMARY

2.1 Establish a Structured Scheduling Method

During SPR-4353, several Excel-based scheduling tools were developed and piloted. This project built on the work from SPR-4353, further developing these Excel tools and linking them to the existing INDOT District sample tracking files.

The Excel master scheduling tool ("HMA Lab Master Schedule") was fully developed and implemented with the following features:

1. When a sample is received, the HMA Lab administration enters the sample number as a new line item the Master Schedule, along with the date received, and specific parametric information obtained from the ITAP database (see Figure 2.1).
2. The "HMA Master Schedule" file was linking to the Districts' "HMA Sample Workbook" files (both Crawfordsville District and Greenfield District), enabling the Master Schedule to *automatically* import in detailed sample information specific to the sample (see Figure 2.2).
 - a. Note that this data previously had to be looked up by the HMA Lab administration and *manually* entered, taking extra non-value-added time, and leading to potential data-entry errors.
3. The HMA Lab administration then enters the planned date for starting the processing of the sample through the lab ("Lab Start Date") (see Figure 2.3).
 - a. Based on information from the Value Stream Map developed during SPR-4353, the Master Schedule automatically calculates target completion dates for each test activity required to be conducted on that sample, including the reporting of the results (see Figure 2.4).
 - b. Based on the calculated target date for reporting of results, the Master Schedule calculates the Planned Turnaround Days (see Figure 2.3). The Master Schedule provides immediate feedback to HMA Lab administration on the adequacy of the schedule, as follows:
 - i. If the Planned Turnaround Days is at, or beyond, the HMA Lab's six-day target, the associated cells turn pink.
 - ii. If the Planned Turnaround Days is four or five days, the associated cells turn yellow.
 - iii. If the Planned Turnaround Days is at, or beyond, the HMA Lab's six-day target, the associated cells turn green.
 1. Note that the "Lab Start Date" selected by the HMA Lab administration is based on capacity considerations, including the bottleneck Extraction operation, using information automatically generated by the Master Schedule, on the "Tests by Target Date" worksheet (see Figure 2.5).
 - iv. An additional benefit of the "HMA Master Schedule" file is the ability to provide reporting of daily schedules for each test type, by target completion date (see Figure 2.6). This provided the capability to display this schedule on a large monitor in the HMA Lab, yielding high visibility to all lab personnel of the schedule and completions for the day.

Enter Data HERE to Schedule Sample													Sample Information (Do not type in these cells)									
Sample #	Date Received	T84/T85 ?	Dryback ?	Weight of Pills	Gyrations Nides	Target DMF Gmb	DMF Gmm	Actual Binder from DMF	Target INDOT	Agg Blend Gub	Lab Start Date	Planned Report Date	Planned Turnaround Days	Actual Turnaround Days	Sample ID	Contract Prefix	Contract #	Lot	Sub	DMF	Mix Size (mm)	Cores?
G1	8/1/19	Yes	No	4700	100	2.388	2.457	5.90	2.633						R193366159011	R	39093	1	1	193399003	19.0mm Inter	No

Figure 2.1 HMA Lab Master Schedule initial sample entry.

Enter Data HERE to Schedule Sample													Sample Information (Do not type in these cells)									
Sample #	Date Received	T84/T85 ?	Dryback ?	Weight of Pills	Gyrations Nides	Target DMF Gmb	DMF Gmm	Actual Binder from DMF	Target INDOT	Agg Blend Gub	Lab Start Date	Planned Report Date	Planned Turnaround Days	Actual Turnaround Days	Sample ID	Contract Prefix	Contract #	Lot	Sub	DMF	Mix Size (mm)	Cores?
G1	8/1/19	Yes	No	4700	100	2.388	2.457	5.90	2.633						R193366159011	R	39093	1	1	193399003	19.0mm Inter	No

Figure 2.2 HMA Lab Master Schedule automatically imports information from districts' "HMA Sample Workbook" files.

Enter Data HERE to Schedule Sample													Sample Information (Do not type in these cells)									
Sample #	Date Received	T84/T85 ?	Dryback ?	Weight of Pills	Gyrations Nides	Target DMF Gmb	DMF Gmm	Actual Binder from DMF	Target INDOT	Agg Blend Gub	Lab Start Date	Planned Report Date	Planned Turnaround Days	Actual Turnaround Days	Sample ID	Contract Prefix	Contract #	Lot	Sub	DMF	Mix Size (mm)	Cores?
G1	8/1/19	Yes	No	4700	100	2.388	2.457	5.90	2.633		8/5/19	8/8/19	6		R193366159011	R	39093	1	1	193399003	19.0mm Inter	No
G2	8/1/19	No	No	4700	100	2.388	2.457	5.90	2.633		8/5/19	8/6/19	4		R193366159012	R	39093	1	2	193399003	19.0mm Inter	No
G3	8/1/19	No	No	4700	100	4.560	2.457	5.90	2.633		8/2/19	8/5/19	7		R193366159013	R	39093	1	3	193399003	19.0mm Inter	No

Figure 2.3 HMA Lab Master Schedule "Lab Start Date" scheduling.

Splitting	209 - Max Gc	166P - Bulk SG Cores	166C - Bulk SG Cores	Extraction	T30 - Gradation	T84/T85	Report Results																
Split Target	Split Actual	Days past Target	209 Target	209 Actual	Days past Target	166P Target	166P Actual	Days past Target	166C Target	166C Actual	Days past Target	Extraction Target	Extraction Actual	Days past Target	T30 Target	T30 Actual	Days past Target	T84/T85 Target	T84/T85 Actual	Days past Target	Report Results Target	Report Results Actual	Days past Target
No	8/5/19											G1	8/5/19		8/6/19			8/6/19			8/6/19		
No	8/5/19											G2	8/5/19		8/6/19			8/6/19			8/6/19		
No	8/2/19											G3	8/2/19		8/5/19			8/5/19			8/5/19		

Figure 2.4 HMA Lab Master Schedule automatically calculates scheduled target dates for each test activity to be conducted.

Tests by Target Date										Update Table "Tests by Target Date"	
Date	Split	209	166P	166C	Extraction	T30	T84/T85	Report Results			
8/1/19	9	9	0	0	9	0	0	0			
8/2/19	23	23	9	0	23	9	0	6			
8/3/19	0	0	0	0	0	0	0	0			
8/4/19	0	0	0	0	0	0	0	0			
8/5/19	23	23	23	2	23	23	0	21			
8/6/19	16	16	23	0	16	23	3	25			
8/7/19	23	23	16	1	23	16	2	18			
8/8/19	22	22	23	1	22	23	1	23			
8/9/19	54	54	22	3	54	22	0	22			
8/10/19	0	0	0	0	0	0	0	0			
8/11/19	0	0	0	0	0	0	0	0			
8/12/19	20	20	54	6	20	54	1	51			
8/13/19	28	28	20	3	28	20	0	20			
8/14/19	30	30	28	1	30	28	4	31			
8/15/19	0	0	30	0	0	30	0	30			
8/16/19	0	0	0	0	0	0	1	1			
8/17/19	0	0	0	0	0	0	0	0			
8/18/19	1	1	0	0	1	0	0	0			
8/19/19	1	1	0	0	1	1	0	0			
8/20/19	1	1	0	0	1	1	0	1			
8/21/19	0	0	0	0	0	1	1	2			
8/22/19	0	0	0	0	0	0	0	0			

Figure 2.5 Master Schedule automatically reports sample loading at each work center.

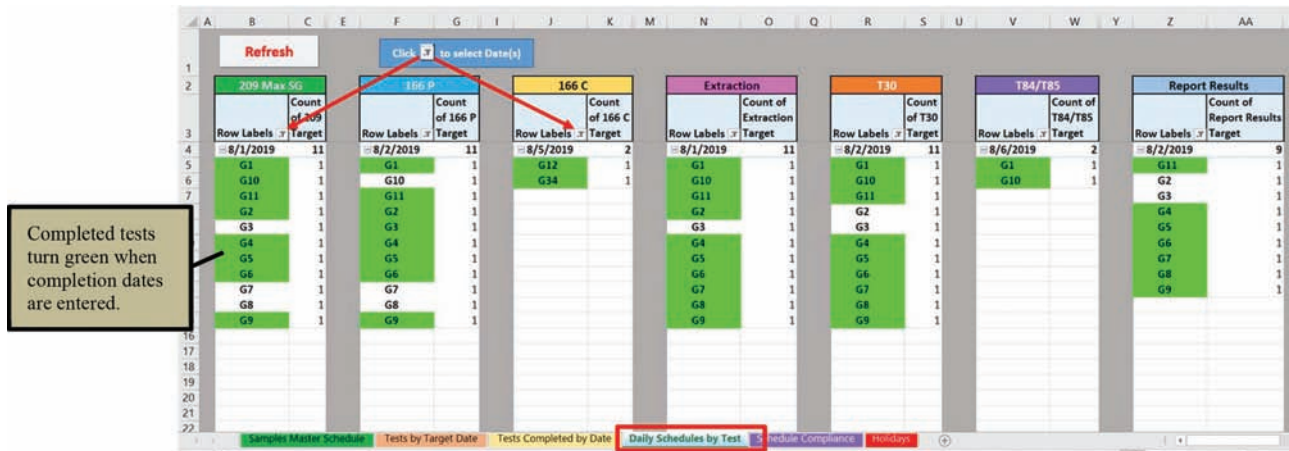


Figure 2.6 Master Schedule automatically reports schedules and completions by test type and by day.

Figure 2.7 Example of existing “Lab Work Sheet” for bulk SG for pills.

2.2 Establish a Work Order (“Test Order”) Routing System

During SPR-4353, a “Test Order” form incorporating a process routing was piloted. However, this approach proved to be cumbersome and required extra paperwork to be generated.

The HMA Lab uses an Excel “Lab Work Sheet” file to generate a specific Work Sheet for each test to be

conducted for each sample (see Figure 2.7). In lieu of the failed “Test Order” routing, the “Lab Work Sheet” file was used as a starting point for establishing a workable Work Order system.

The following revisions were made to the existing “Lab Work Sheet” file to facilitate implementation of the Work Order system to support the Master Scheduling system described in Section 2.1:

1. The file was linked to the “HMA Lab Master Schedule” file, to enable automatic importing of sample information and target dates from the Master Schedule.
2. A “Test Target Completion Date” field was added, and automatically populated for each test, from the Master Schedule (see Figure 2.8).
3. Sample-specific information is automatically populated for each test, from the Master Schedule (see Figure 2.8).
 - a. Note that previously all of this information, which had already been manually entered into the old tracking spreadsheet, had to be also manually entered into this file. Having this data imported in automatically eliminated the redundant, non-value-added data-entry time, and reduced the potential for data-entry errors.
4. The title block for each Work Sheet was color-coded to indicate the type of test to which the Work Sheet applies. This provided a visual control during processing of samples through the lab.
 - a. Note that this same color-coding is carried throughout the new “HMA Master Schedule” file, so that the same colors are always used to designate the same test types. This provides further reinforcement of the visual controls.

The combination of these revisions to the “Lab Work Sheet” file resulted in the ability of the HMA Lab administration to simply create the file, enter the Sample Number, and print the full set of Work Sheets, with no additional manual data enter (see Figure 2.9).

The implementation of the automatic importing of data into the “HMA Lab Master Schedule” and the “Lab Work Sheet” reduced the administrative time for entering each sample from ten minutes per sample (see Figure 2.10, excerpt from the Value Stream Map from

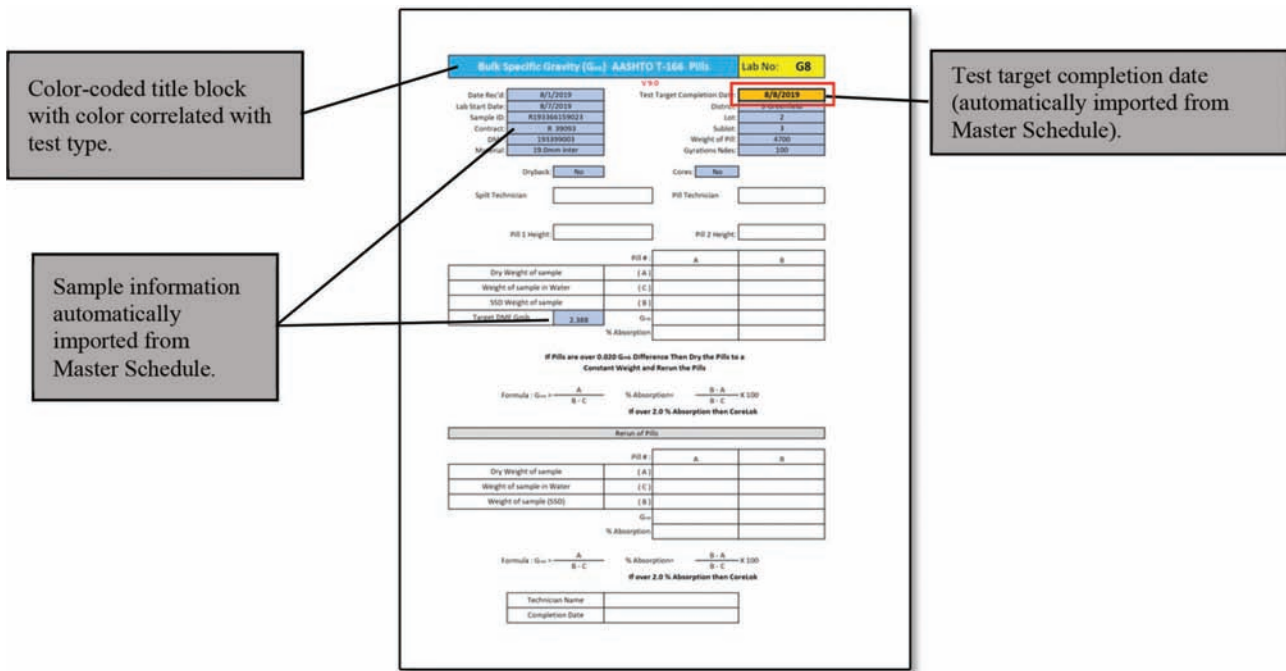


Figure 2.8 Example of revised “Lab Work Sheet” for bulk SG for pills.

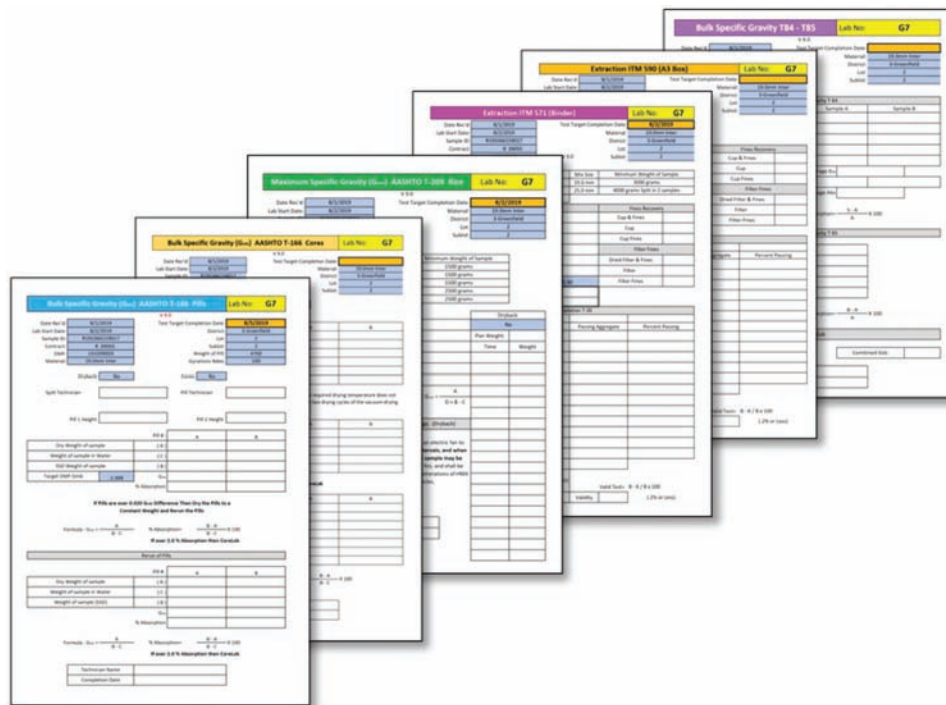


Figure 2.9 Full set of color-coded lab work sheets printed with no manual data entry.

SPR-4353), to under two minutes. This consequently reduced the queue of samples waiting to be entered, hence allowing the actual testing to be started earlier in the morning for each sample (e.g., if 20 samples received are in a morning, the batch processing time to get all samples started is reduced from 3.3 hours to under 40 minutes).

2.3 Use the Resource vs. Demand Model to Facilitate/ Trigger Planning of Overtime

During SPR-4353, a Resource vs. Demand modeling tool (Excel) was developed (see Figure 2.11). The piloting of this tool was deemed successful, so no further development was required during this project.

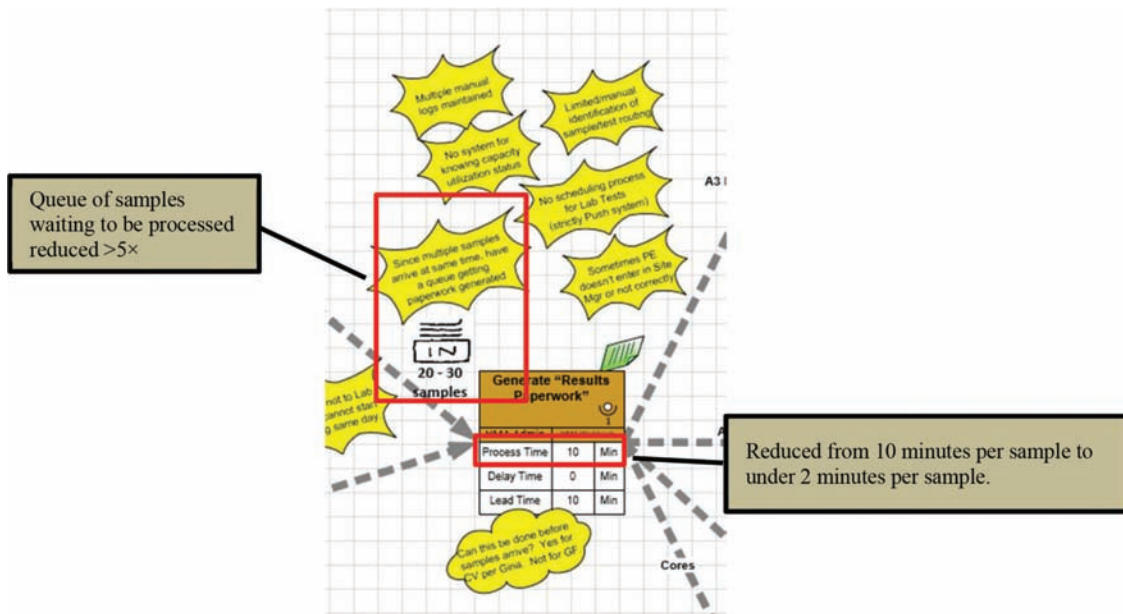


Figure 2.10 Effect of automatically populating sample data on Value Stream Map.

Incoming samples per week: 51		224 # Samples per month		10.2 Average # Samples received per day											
Sample Type	Weekly Demand	Work Center Samples/Week*							Work Center Hours/Week						
		Admin	Splitting	Counter	Cores	Extraction	Gradation	T84/T85	Admin	Splitting	Counter	Cores	Extraction	Gradation	T84/T85
Paperwork generation	51	51	0	0	0	0	0	0	12.8	0	0	0	0	0	0
A1	51	0	102	51	0	51	51	0	0	34.0	25.5	0	76.5	29.8	0
A2	51	0	102	51	0	0	0	0	0	34.0	4.3	0	0	0	0
Cores	45.9	0	0	45.9	45.9	0	0	0	0	0	4	7.7	0	0	0
A3 (T84/T85)	7.7	0	15.3	0	0	15.3	15.3	7.65	0	5.1	0	0	23.0	8.9	19.1
Results entry/reporting	51	51	0	0	0	0	0	0	17.0	0	0	0	0	0	0
Weekly Demand:	102.0	219.3	147.9	45.9	66.3	66.3	7.7	29.8	73.1	33.6	7.7	99.5	38.7	19.1	
Monthly Demand:	448.8	964.92	650.76	201.96	291.72	291.72	33.66	131	322	148	34	438	170	84	
Daily Demand:	20.4	43.9	29.6	9.2	13.3	13.3	1.5	6.0	14.6	6.7	1.5	19.9	7.7	3.8	
* For each sample received:		4 Splittings (2 A1 & 2 A2)(or 6 if T84/T85)		2 Counters (Max & Bulk) (3 if Cores)		1 Extraction (3 if T84/T85)		1 Gradation (3 if T84/T85)		# People:		0.8 Admin		1.9 Lab Techs	
Assumptions:		90% % of Samples with Cores		15% % of Samples with T84/T85		7.5 Hours per shift		8 Current # Lab Techs		90% Lab Tech Load Factor		0% % SMA Samples		Process Times:	
		Admin Paperwork gen: 15		Splitting/Crumble A1: 20		Splitting/Pill A2: 20		Splitting/Crumble A3: 20		Counter Max: 30		Counter Bulk: 5		Cores (Cut/Label): 10	
		Extraction: 90		Gradation: 35		T84/T85: 150		Total Lab Techs: 7.2		Total w/ Admin: 8.0		Total Lab Techs w/ Load Factor: 8.0		Based on overnight oven drying, not Core Dryers	

Figure 2.11 Resource modeling vs. demand for each Work Center (reference SPR-4353 Figure 3.6).

2.4 End-of-Shift for Reporting Test Results

During SPR-4353, it was identified that results of tests need to be reported by the end of the day in which the tests are completed, in order to avoid impacting the Turnaround Time metric. The HMA Lab staff responded to this realization, and adjusted accordingly, with no subsequent occurrences of next-day reporting. The administrative time savings associated with the improvements described in section 2.2 above will

provide additional time availability for results reporting. No further action was required in this project.

2.5 Performance Metric for Schedule Compliance

The "HMA Lab Master File" includes fields to capture completion dates for each test. This data was used to create a reporting tool for compliance to the target completion date for each test, by test type, by date (see Figure 2.12). The "HMA Lab Master File"

Figure 2.12 Schedule Compliance Reporting from the HMA Lab Master Schedule.

Tests Completed by Date								Report Results	Update Table "Tests Completed by Date"
Date	Split	209	166P	166C	Extraction	T30	T84/T85		
8/1/19	8	0	0	0	10	0	0	0	
8/2/19	25	0	7	0	23	9	0	7	
8/3/19	0	0	0	0	0	0	0	0	
8/4/19	0	0	0	0	0	0	0	0	
8/5/19	23	0	23	1	23	23	0	15	
8/6/19	17	0	24	1	16	23	2	21	
8/7/19	21	0	16	1	23	16	2	20	
8/8/19	24	0	23	1	22	23	1	25	
8/9/19	54	0	22	2	54	22	0	27	
8/10/19	0	0	0	1	0	0	0	0	
8/11/19	0	0	0	0	0	0	0	0	
8/12/19	20	0	54	6	20	54	1	50	
8/13/19	27	0	20	3	28	20	0	21	
8/14/19	31	0	27	0	30	28	4	30	
8/15/19	0	0	31	1	0	30	0	31	
8/16/19	0	0	0	0	0	0	1	0	
8/17/19	0	0	0	0	0	0	0	1	
8/18/19	0	0	0	0	1	0	0	0	
8/19/19	2	0	1	0	0	0	0	0	

Figure 2.13 Reporting Tests Completed by Date from the HMA Lab Master Schedule.

also includes reporting of Tests Completed by Date (see Figure 2.13).

3. CONCLUSIONS

All of the implementation objectives for this project have been achieved, as follows:

1. Establish a structured scheduling method.
 - a. A specific schedule is assigned to each test for each sample.
 - b. The schedule is based on the date planned for bottleneck Extraction operation.
 - c. Dates are scheduled for Extraction based on the available capacity at Extraction.
2. Establish a Work Order ("Test Order") routing system to communicate scheduled dates and to provide visual identification and control of the flow samples in the lab.
 - a. This was achieved via the implementation of the revised "Lab Work Sheet" file, linked with the "HMA Master Schedule" file.
3. Use the Resource vs. Demand model to facilitate/trigger planning of overtime.
 - d. All other processes/tests are scheduled based on the planned Extraction date.
 - e. Do not load schedule to 100% of capacity, allowing time for reruns, appeals, etc.
 - i. All of the above were achieved via the implementation of the new "HMA Lab Master Schedule," linked to the Districts' "HMA Sample Workbook" files.

- a. This was achieved via the successful pilot of the Excel tool developed during SPR-4353.
- 4. Adjust/stagger schedules of lab management/administration staff to provide resources at end-of-shift for reporting test results.
 - a. This was achieved via the verification that the actions taken during SPR-4353 were suitably effective.
- 5. Establish and communicate a performance metric for schedule compliance (i.e., compliance to the specific schedules for each sample).
 - a. This was achieved via the reporting capabilities built into the new “HMA Master Schedule” file.

Further benefits beyond the stated objectives included the following:

1. Dramatic (5 ×) reduction in the time required for entering samples into the HMA Lab process (via automatic importing data from linked files), with reduced opportunity for error.
2. Enabling visual reporting of daily sample schedules by test type (via displaying reports from the “HMA Master Schedule” on TV monitors in the HMA Lab).

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1 — evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at <http://docs.lib.purdue.edu/jtrp>.

Further information about JTRP and its current research program is available at <http://www.purdue.edu/jtrp>.

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