

JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION
AND PURDUE UNIVERSITY



Striping Truck Utilization at Crawfordsville and Greenfield



Jon Padfield

Jim Handy

Ted Boehm

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AUTHORS

Jon Padfield, PhD

Technical Assistance Program
Purdue University

Jim Handy

Principal Investigator
Technical Assistance Program
Purdue University
(317) 275-6813
jhandy@purdue.edu
Corresponding Author

Ted Boehm

Technical Assistance Program
Purdue University

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16. Abstract <p>At the time this project was launched, INDOT was operating two paint trucks per district (one edge line truck and one center line truck). This project was launched to determine the feasibility of painting all the lane miles in each district with a single paint truck per district.</p> <p>The Greenfield and Crawfordsville districts were chosen to develop and test ideas to enable the transition to painting with just one truck per district. Teams from both districts including paint truck drivers, painters and managers participated in a series of Value Stream Mapping (VSM) sessions facilitated by Purdue Technical Assistance Program (TAP). The Value Stream Maps were then used to identify inefficiencies in the painting operation and opportunities for improvement. These improvement ideas included both process changes and physical alterations to existing paint trucks. An action plan was created for each district to follow to enable them to test the ideas during the 2nd half of the 2013 and first half of the 2014 paint season.</p> <p>The action plans were completed and progress was tracked regarding the performance of the modified trucks and processes. Although the Crawfordsville and Greenfield districts implemented different approaches, both were able to complete painting all of their scheduled lane miles during the season with just 1 truck apiece.</p> <p>The results of this project demonstrated the viability of reducing the statewide fleet of INDOT paint trucks from 12 to 6. At an approximate cost of \$400,000 per truck, this translates into an approximate savings of \$2,400,000 as the current fleet of 12 aging trucks is replaced with 6 trucks rather than 12.</p> <p>The process changes implemented in this project also demonstrated operational efficiency improvements, which will result in labor savings of approximately 10%.</p>			
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EXECUTIVE SUMMARY

STRIPING TRUCK UTILIZATION AT CRAWFORDSVILLE AND GREENFIELD

Introduction

The Indiana Department of Transportation (INDOT) is divided into six districts, with district offices located in LaPorte, Fort Wayne, Crawfordsville, Greenfield, Vincennes and Seymour. Prior to the launch of this project in February 2013, each district used separate trucks to paint the white edge lines and yellow centerlines on state roads.

The total statewide annual cost for the paint operations in fiscal year 2012 was \$10,197,576. This figure includes \$8,253,737 for material (paint and beads), \$1,059,402 for equipment and fuel, and \$884,437 for 54,733 hours of labor. The age of the twelve existing paint trucks range from 6 to 19 years, with a median age of 9 years.

In an effort to reduce the cost of paint operations, this project was launched to find ways to improve the efficiency of the paint operations and to reduce the need to replace the existing twelve trucks as they wear out. The goal of this project was to determine the feasibility of painting all the required lane miles with just one paint truck per district rather than two trucks per district.

Upon the successful demonstration that districts can complete their required operations with a single truck, INDOT plans to redistribute the six best paint trucks in the existing fleet so that each district would have one of the best trucks. The remaining trucks would be retired from the fleet and the best of those retired trucks may be saved as an emergency replacement truck for any district needing it if its truck should break down for an extended period or if weather or some other circumstance jeopardized the district's ability to complete the painting with one truck.

Findings

Although the Crawfordsville and Greenfield districts pursued slightly different approaches to increasing their truck's paint capacity and different staffing models (carrying four totes vs. one larger tank; using a four-days-per-week work schedule vs. three long days per week), both districts were able to paint all their required lane miles with just one truck per district.

While both approaches enabled the districts to meet the original objective of painting the district with a single truck, the Greenfield approach of carrying 1,390 gallons of paint seemed more optimal

for running 12.5-hour shifts as it reduced the number of times the truck had to be refilled during the extended day. The Crawfordsville approach of carrying 1,100 gallons of paint in totes worked well for a standard length day, but it may not have worked as well if they had also gone to a three-day workweek with 12.5-hour days on the road.

Implementation

There are several benefits associated with the improvements documented in this project.

First, new paint trucks cost approximately \$400,000 each (depending on model and options). By reducing the need from two to one truck per district, this project has the potential to save the taxpayers of Indiana \$2.4 million in acquisition costs by replacing only six of the twelve current trucks. In addition, some of the operational efficiencies achieved by the Greenfield district's compressed workweek suggest the possibility of reducing the number of trucks even further to perhaps four for the state. However, an additional study would have to be completed before any firm decision could be made about reducing the trucks below a level of one per district.

The results achieved by the Crawfordsville and Greenfield district paint crews this season were shared with the other districts in a statewide Traffic Operations Managers meeting held in Indianapolis on September 24. During this meeting the changes to the trucks and operations were discussed, and both the Greenfield and Crawfordsville paint trucks were available for inspection in the parking lot to allow the staff from other districts to see the changes in detail.

The remaining four districts (LaPorte, Fort Wayne, Vincennes and Seymour) have been asked for details about their current paint trucks so that the INDOT central office can select the four best trucks from those districts to be upgraded with either a higher capacity paint tank or a modification allowing them to carry paint totes. Once the four best trucks have been upgraded, they will be distributed to the remaining four districts so that during the next paint season all six districts will be painting with a single truck per district.

Based upon the experience of the Crawfordsville district (8.7% reduction in equipment and labor cost) and Greenfield district (10% reduction in equipment and labor cost), the average savings in equipment and labor cost was 9.35%. Assuming all six districts achieve this level of savings next year, and based upon the \$1,943,839 cost of equipment and labor in FY 2012, the annualized statewide savings for paint operations would be \$181,748.

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1. INTRODUCTION

The Indiana Department of Transportation (INDOT) is divided into six districts, with district offices located in LaPorte, Fort Wayne, Crawfordsville, Greenfield, Vincennes and Seymour. Prior to the launch of this project in February 2013, each district used separate trucks to paint the white edge lines and yellow centerlines on state roads.

The total statewide, annual cost for the paint operations in fiscal year 2012 was \$10,197,576. This figure includes \$8,253,737 for material (paint and glass beads), \$1,059,402 for equipment and fuel, and \$884,437 for 54,733 hours of labor. The age of the twelve existing paint trucks range from 6 to 19 years with a median age of 9 years.

In an effort to reduce the cost of paint operations, this project was launched to find ways to improve the efficiency of the paint operations and to reduce the need to replace the existing twelve trucks as they wear out. The goal of this project was to determine the feasibility of painting all the required lane miles with just one paint truck per district rather than two trucks per district.

Upon the successful demonstration that districts can complete their required operations with a single truck, INDOT plans to redistribute the six best paint trucks in the existing fleet so that each district would have one of the best trucks. The remaining trucks would be retired from the fleet and the best of those retired trucks may be saved as an emergency replacement truck for any district needing it if its truck should break down for an extended period or if weather or some other circumstance jeopardized the district's ability to complete the painting with one truck.

2. PROBLEM STATEMENT

A way needs to be found and implemented to demonstrate that a district can meet painting needs for both edge line and centerline with a single truck. In addition, improvements in operational efficiency (equipment, material and/or labor) are needed to reduce the annual cost of the painting operation.

3. OBJECTIVES

1. Find a reliable way to ensure a district can paint its required number of painted miles per year using a single paint truck.
2. Find ways to improve the operational efficiency to reduce the overall annual cost of paint operations across the six INDOT districts.

4. WORK PLAN

Two INDOT districts, Crawfordsville and Greenfield, were chosen to participate in this project. Teams were drawn from these two districts consisting of paint crew

managers, drivers and operators. The teams met for a series of four facilitated offsite meetings at a conference room in the INDOT facility on 30th Street in Indianapolis during February of 2013.

Value stream mapping (VSM) was conducted on the paint operations of the Crawfordsville and Greenfield districts during these meetings. This process involved creating "current state" maps that visually depicted the paint operations processes at the two districts as they existed at the time (see Figures 4.1, 4.2, and Appendix C). Once the current state maps were created, the differences between the two districts were noted.

While there were many similarities noted between the two value stream maps (see Appendix C), there were also notable differences in details such as how paint was loaded on the trucks (Crawfordsville used tow motors to put totes on paint on a tower then gravity fed paint into the tank on the truck while Greenfield used pumps to transfer paint from totes on the ground into a tank on the paint truck). Another difference between the districts was found in the way sub districts were used (Greenfield had the paint vendor to deliver paint to sub districts where the paint truck and escort vehicles were sometimes stored when painting in the sub district while Crawfordsville always operated out of the main district office).

Once the current state maps had been compared and a discussion had been held regarding the time each step in the process typically consumed, the teams brainstormed ideas to improve the process. Because the customer always defines "value," a discussion was held regarding various customers related to the paint operations. A decision was reached that there were 3 main customers of the process who each had a different stake in any changes made to the existing process. Those customers were taxpayers, the motoring public, and INDOT paint crew employees.



Figure 4.1 Patrick Szewczak documents process steps on Greenfield's current state map.



Figure 4.2 Randy Morris documents process steps on Crawfordsville’s current state map.

Taxpayers want a high quality (straight, long lasting, high visibility) line painted on the roads at the lowest possible cost. The motoring public wants the minimum inconvenience possible (i.e., to not get stuck for a lengthy amount of time behind a paint truck on the highway). Meanwhile, INDOT paint crew employees expect and deserve a safe paint process that does not create new safety hazards. It was decided that any potential improvements to the paint process would be evaluated against these 3 criteria (cost to the taxpayers, inconvenience to the motoring public, and the safety impact for INDOT paint crew employees).

The teams proposed several changes including changing the way glass beads are loaded onto the paint trucks. The glass beads were originally loaded using a vacuum system, which sucked beads from a pallet on the ground, through a 2" diameter tube and into a bead tank on the truck (see Figure 4.3). Under the proposed change, beads would be purchased in sling bags so that a cage could be constructed to allow a tow motor to lift the beads over the bead tank so they could be gravity fed into the tank (see Figures 4.4 and 4.5). Also, a safety “collar” was fabricated to be placed over the bead inlet while it is



Figure 4.3 Sucking glass beads from pallet on ground into the bead tank.



Figure 4.4 A sling bag of glass beads prepared to be lifted over a bead tank on a paint truck.



Figure 4.5 A sling bag of glass beads being gravity fed into a paint truck bead tank.

being filled to protect the hands and arms of the operator in the event anything happened which might cause the bag of beads to drop onto to the bead tank

(see the metal structure near the operator's hands in Figure 4.5).

Another proposed change to the paint process was to increase the amount of paint that could be carried on the paint trucks to allow them to go reduce the amount of down time caused each day by having to splash fill the trucks while on the road.

During the 2012 paint season, both the Greenfield and Crawfordsville paint crews carried approximately 1,000 gallons of paint apiece on their paint trucks. Greenfield wanted to increase its capacity by removing the existing tank and installing a new tank capable of holding both 695 gallons of yellow and 695 gallons of white paint for a total of 1,390 gallons (see Figure 4.6). It should also be noted that the new paint tank loaded paint from the top rather than the bottom, which reduced the pressure on the pump thus cutting the time required to fill the tank by nearly 50%. In addition, two pumps were used to fill both the white and yellow paint tanks at the same time. Together, these two improvements reduced the time required to fill the 1,390-gallon tank by approximately 35 minutes.

However, Crawfordsville proposed doing away completely with its paint tank and instead loading four 275-gallon paint totes directly onto the truck. While this approach resulted in less total paint being carried on the truck than the larger paint tank proposed by Greenfield (1,100 gallons vs. 1,390 gallons) the Crawfordsville approach had the advantage of allowing the ratio of white to yellow paint to vary from all one color, 25/75, 50/50, or 100/0 (see Figure 4.7).

After a lengthy discussion about the advantages and disadvantages of each approach it was decided to allow each district to implement its own approach and



Figure 4.6 Greenfield paint truck modified with a 1,390-gallon paint tank.



Figure 4.7 Crawfordsville paint truck modified to carry four 275-gallon paint totes.

measure the improvement each district achieved at the end of the paint season.

Another common improvement between the districts was adding a glass bead manifold near the bead guns (see Figure 4.8) to ensure the bead gun did not run out of beads while the truck was simultaneously spraying



Figure 4.8 Glass bead manifold near bead guns.

edge line and center line paint. This was believed to be necessary based upon preliminary results of a very short test conducted by the Greenfield paint crew in the Fall of 2012 in which they attempted to spray edge line and center line paint at the same time.

A fourth improvement that was only implemented by the Greenfield district was to move to longer workdays for the paint crews. INDOT employees typically work a 37.5-hour workweek so the Greenfield district opted to work three 12.5-hour days rather than a traditional four-day workweek. This change allowed the Greenfield district to minimize the time and fuel required to drive to the stretch of road that needed painting (non-value added time) and to maximize the time actually spent painting the road (value added time).

Both districts created a project plan (see Appendix A and Appendix B) to implement changes to their processes and equipment. The project plans included making changes to their glass bead loading process, modifying their best paint truck to have either a larger capacity paint tank or to carry four 275-gallon totes, and installing bead manifolds in close proximity to their paint guns.

5. ANALYSIS OF DATA

Data was collected and compared for both the Crawfordsville and Greenfield districts to determine the financial effect of these changes had on their operations. For both districts, the data was pulled from the INDOT work order tracking system to record the number of lane miles painted, the labor cost and equipment cost.

Because material cost fluctuates from year to year and this project did not address the cost of material, those costs were excluded from the analysis in Table 5.1 that compares costs of painting in calendar year 2012

TABLE 5.1
Labor and Equipment Cost per Mile 2012 vs. 2013

	Crawfordsville			Greenfield		
	CY 2012	CY 2013 (thru 9/9)	% Change	CY 2012	CY 2013 (thru 9/9)	% Change
Miles Painted	3,343	2,170		3,107	2,862	
Labor Cost	\$54,649	\$36,469		\$53,421	\$44,089	
Equipment Cost	\$66,505	\$35,396		\$50,186	\$41,886	
L&E Cost Mile	\$36.24	\$33.12	-8.7%	\$33.34	\$30.04	-10.0%

TABLE 5.2
Miles per Labor Hour 2012 vs. 2013

	Crawfordsville			Greenfield		
	CY 2012	CY 2013 (thru 9/9)	% Change	CY 2012	CY 2013 (thru 9/9)	% Change
Miles Painted	3,343	2,170		3,107	2,862	
Labor Cost	3,372	2,106		3,249	2,550	
Miles/Labor Hour	0.99	1.03	4.0%	0.96	1.12	17.3%

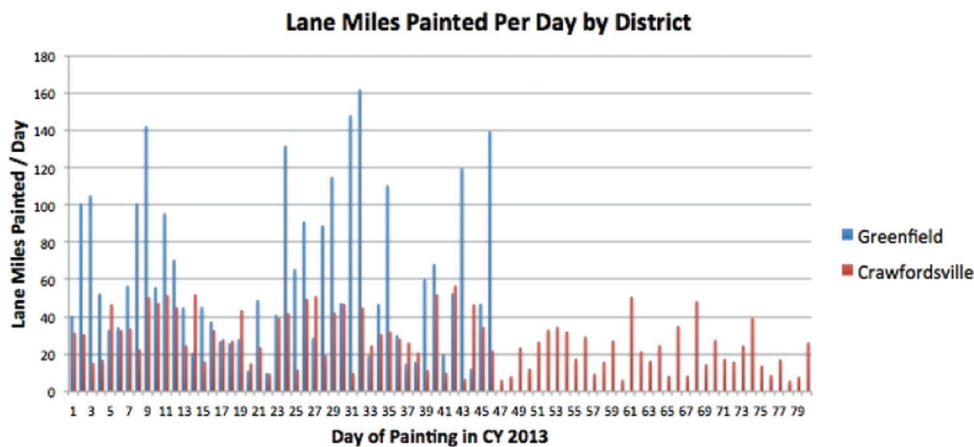


Figure 5.1 Lane miles per day by district.

vs. 2013 (thru 9/9/13). By painting the edge line and centerline at the same time where possible, both districts were able to lower their labor and equipment cost per mile by an average of 9.35%.

The difference in actual cost per mile between districts is likely related to the compressed workweek implemented in the Greenfield district. In 2012 Crawfordsville and Greenfield both generally worked a four-day workweek (as weather permitted). As a result of being able to carry more paint, the Greenfield district decided to go to a three-day workweek in 2013 that eliminated more deadhead travel time and allowed a greater percentage of the labor hours worked to be value added (painting time) rather than non-value added (travel time). This difference can clearly be seen by the 17.3% increase in miles per labor hour in the Greenfield district shown in Table 5.2.

Due to the longer work days (often three-day workweeks when weather permitted), the Greenfield district was able to average 62 lane miles per day in comparison to an average of 27 lane miles per day in

Crawfordsville. The daily miles painted for each district are shown in Figure 5.1.

6. CONCLUSIONS

Although the Crawfordsville and Greenfield districts pursued slightly different approaches to increasing their truck's paint capacity (carrying four totes vs. one larger tank) and different staffing models (a traditional four-days-per-week work schedule vs. three long days per week), both districts were able to meet their painting needs with just one truck per district.

While both approaches enabled the districts to meet the original objective of painting the district with a single truck, the Greenfield approach of carrying 1,390 gallons of paint seemed more optimal for running 12.5-hour shifts as it reduced the number of times the truck had to be refilled during the extended day. The Crawfordsville approach of carrying 1,100 gallons of paint in totes worked well for a standard length day, but it may not have worked as well if that district had

also gone to a three-day workweek with 12.5-hour days on the road.

It should also be noted that Greenfield paint operations scored the highest of all six districts for its paint quality assurance (QA) evaluation. This demonstrates that the improved efficiency of the single truck paint operation did not negatively impact the quality of the paint operation.

7. RECOMMENDATIONS

Because this was the first year in which it attempted to paint with just one truck, the Greenfield district has identified another change it plans to implement next year to further improve upon the success of this project. That change involves the way in which the lane miles are scheduled. During the paint season documented in this study, the Greenfield district focused the first part of its season on painting all the lane miles in which it could paint both edge line and centerline at the same time. It was then left with sections of road spread out around the district that only needed either edge or center lines painted on them. In the next paint season the Greenfield district will spread out its single and dual line painting as it moves around the district to avoid the inefficiency of having to send trucks out at the end of the season to cover relatively small sections of single line painting that were skipped earlier in the season while painting dual lines.

The Greenfield district also determined during the year that it was important to always carry extra paint and glass beads in a supply truck and to always refill beads and paint during the lunch break so crews would have the flexibility to paint later into the day if needed (i.e., the weather was good and there were more lane miles to be painted in the vicinity of where the trucks were currently located). This schedule flexibility allowed the district to reduce its deadhead travel time (non-value added miles traveled) and to maximize the percent of time crews were actually putting paint on the road.

Based upon the successful pilot of a single paint truck operation in two districts, it appears to be a viable option to implement this approach in the remaining four districts. During the 2013 paint season, neither Greenfield nor Crawfordsville suffered any significant downtime with its paint truck (i.e., major mechanical problem). If all six districts adopt the single truck approach, it may be appropriate for INDOT to maintain a seventh paint truck that could be sent to any district that experiences a significant mechanical problem with its paint truck or a district that is at risk of not meeting its painting needs due to prolonged weather-related issues.

8. EXPECTED BENEFITS, DELIVERABLES, IMPLEMENTATION AND COST SAVINGS

There are several benefits associated with the improvements documented in this project.

First, new paint trucks cost approximately \$400,000 each (depending on model and options). By reducing the need from two to one truck per district, this project has the potential to save the taxpayers of Indiana \$2.4 million in acquisition costs by replacing only six of the twelve current trucks. In addition, some of the operational efficiencies achieved by the Greenfield district's compressed workweek suggest the possibility reducing that number even further to perhaps four for the state. However, an additional study would have to be completed before any firm decision could be made about reducing the trucks below a level of one per district.

Another advantage is that by getting the work accomplished in a shorter time period (Greenfield was essentially done in three months), the manpower normally assigned to the paint crews can be freed up earlier in the year to be utilized in other areas.

The results achieved by the Crawfordsville and Greenfield district paint crews this season were shared with the other districts in a statewide Traffic Operations Managers meeting held in Indianapolis on September 24. During this meeting the changes to the trucks and operations were discussed and both the Greenfield and Crawfordsville paint trucks were available for inspection in the parking lot to allow the staff from other districts to see the changes in detail.

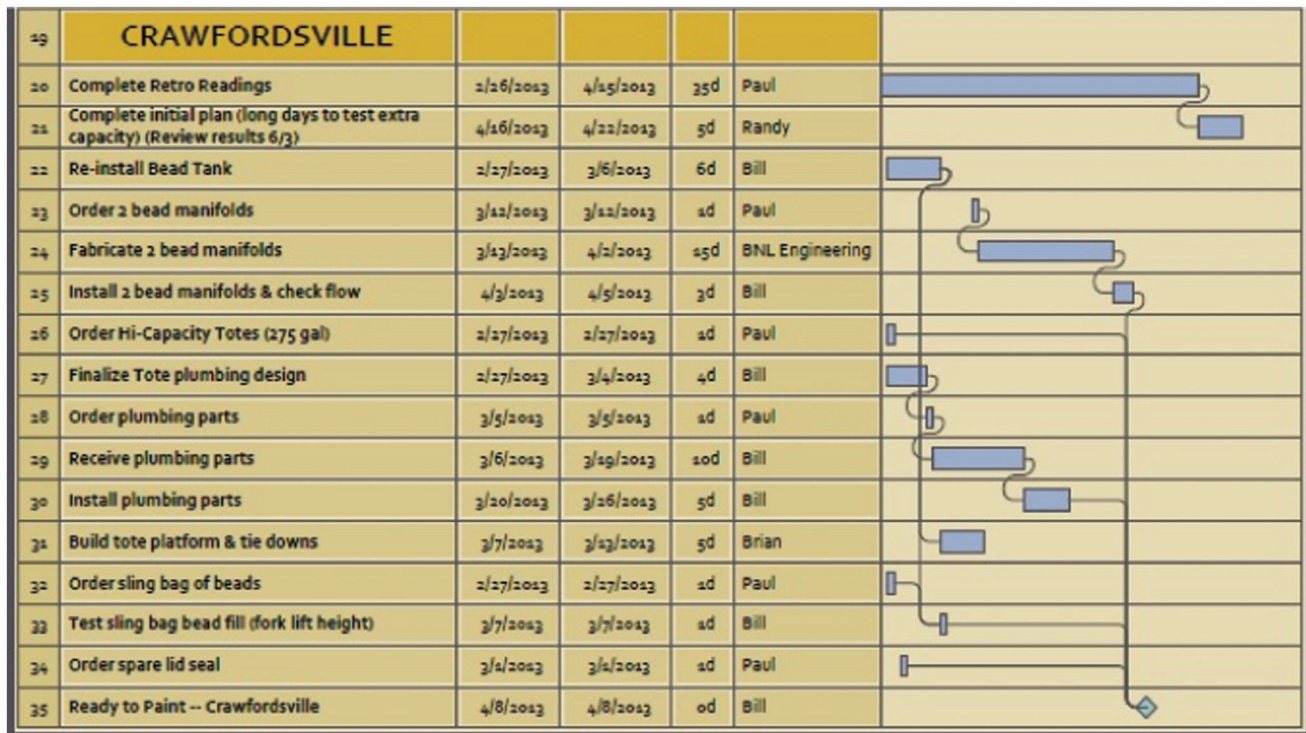
The remaining four districts (LaPorte, Fort Wayne, Vincennes and Seymour) have been asked for details about their current paint trucks so that the INDOT central office can select the four best trucks from those districts to be upgraded with either a higher capacity paint tank or a modification allowing them to carry paint totes. Once the four best trucks have been upgraded, they will be distributed to the remaining four districts so that during next paint season all six districts will be painting with a single truck per district.

Based upon the experience of the Crawfordsville district (8.7% reduction in equipment and labor cost) and Greenfield district (10% reduction in equipment and labor cost), the average savings in equipment and labor cost was 9.35%. Assuming all six districts achieve this same level of savings next year, and based upon the \$1,943,839 cost of equipment and labor in FY 2012, the annualized statewide savings for paint operations would be \$181,748.

APPENDIX A. GREENFIELD PROJECT PLAN

ID	Task Name	Start	Finish	Duration	Resource Names	Mar 2013					Apr 2013			
						2/24	3/3	3/20	3/27	3/24	3/31	4/7	4/14	4/21
1	GREENFIELD													
2	Complete Retro Readings	2/26/2013	4/15/2013	35d	Patrick									
3	Complete initial plan (long days to test extra capacity) (Review results 6/3)	4/16/2013	4/22/2013	5d	Tom									
4	Issue RFQ for 1396 gal Tank	3/4/2013	3/4/2013	1d	JD									
5	Award contract for 1396 gal Tank	3/15/2013	3/15/2013	1d	JD									
6	Fabricate tank	3/18/2013	4/22/2013	26d	Vendor									
7	Place order for 2nd bead manifold	3/4/2013	3/4/2013	1d	Patrick									
8	Install tank	4/23/2013	4/23/2013	1d	Bob									
9	Receive 2nd bead manifold	3/4/2013	3/15/2013	10d	Patrick									
10	Install 2nd bead manifold & check flow	3/18/2013	3/19/2013	2d	Bob									
11	Fab & Install "Safety Ring" for top of bead tank	2/27/2013	3/19/2013	25d	INDOT Garage									
12	Order spare lid seal	3/4/2013	3/4/2013	1d	Patrick									
13	Design fixture for lifting sling bag of beads	3/4/2013	3/4/2013	1d	Patrick									
14	Fabricate Lift Fixture	3/4/2013	3/15/2013	10d	INDOT Garage									
15	Order Hi-Flow Paint Pump	3/4/2013	3/15/2013	10d	Tom									
16	Test Hi-Flow Paint Pump	3/18/2013	3/22/2013	5d	Jim									
17	Order 2nd Hi-Flow Pump	3/25/2013	3/25/2013	1d	Tom									
18	Ready to Paint -- Greenfield	4/24/2013	4/24/2013	0d	Tom									

APPENDIX B. CRAWFORDSVILLE PROJECT PLAN



APPENDIX C. GREENFIELD AND CRAWFORDSVILLE DISTRICT VALUE STREAM MAPS

Appendix C is available for download at <http://dx.doi.org/10.5703/1288284315229>.

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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.

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