RUTGERS

Quarterly Progress Report

Project Title:	Highway Repair Consolidation Feasibility
NJDOT PROJECT NUMBER: 2012-08	NJDOT RESEARCH PROJECT MANAGER: Smmamunar Rashid
TASK ORDER NUMBER: 283	PRINCIPAL INVESTIGATOR: Dr. Hao Wang
Project Starting Date: 9/17/2012 Project Ending Date: 9/17/2014 Modified Ending Date: 03/31/2015	Period Starting Date: 07/01/2014 Period Ending Date: 09/30/2014

1. Project Progress Summary

Task No.	Task Description	Percent of Total Project Budget	Cost of Task	% of task this quarter	Cost this quarter	% of task to date	Total Cost to date
1	Conduct a Review of Existing Resources	5.24%	$ 16,848.84	0%	$0.00	100%	$16,848.84
2	Determine the Current NJDOT Work Zone Practice	10.47%	$ 33,697.68	0%	$0.00	100%	$33,697.68
3	Develop a Benefit Cost Analysis Process	10.24%	$ 32,939.80	15%	$4,940.97	85%	$27,998.83
4	Develop a Framework for Managing and Coordinating Workzone Projects	27.38%	$ 88,121.32	15%	$13,218.20	85%	$74,903.12
5	Develop an Interface for Work Zone Coordination and Management	29.76%	$ 95,787.85	25%	$23,946.96	75%	$71,840.89
6	Training and Technology Transfer	9.53%	$ 30,666.14	0%	$0.00	0%	$0.00
7	Project Management, Final and Quarterly Reports	7.38%	$ 23,757.49	10%	$2,375.75	70%	$16,630.24
Total		**100%**	**$321,819.12**	**13.82%**	**$44,481.88**	**75.17%**	**$241,919.60**

2. Project Overview

Project Abstract

New Jersey's aging highway transportation infrastructure constantly requires reconstruction, maintenance and expansion to meet the ever-increasing demand for travel. As travel demand increases with little growth in roadway capacity, a large number of work zones are expected in order to keep the existing highway system operable. The increasing number of work zones adversely affects the mobility and safety of travelers on the already congested roadways. Drivers are constantly faced unfavorable road conditions and unexpected delays due to work zones.

Faced with the growing number of work zones, the challenge for transportation agencies is to effectively manage the impacts of work zones to alleviate congestion and maintain the safety of motorists without disrupting project schedules.

The NJDOT wants to minimize the negative impacts of work zones through successful project coordination. The major goal of this research is the development of an understanding of the types of work zones that can be coordinated, in terms of construction compatibility, design completion, and construction schedules. The goal also includes a quantitative analysis of the effectiveness of coordinating short- and, when possible, long-term projects to measure the efficiency of various combinations of projects relative to each other and the status quo.

Project Objectives

The objectives of this research are:

1. To develop a documented and vetted process, within the NJDOT, which delineates the appropriate stakeholders who will determine and prioritize which projects and/or problem statements can be coordinated for a consolidated work zone approach.
2. To develop and/or refine a data management process / interface, with current inter- and intra-agency data resources, that can be incorporated into the existing NJDOT's in-house automated data management system.

Various tasks have to be completed to achieve these objectives. The most important steps are:

- Conduct brief interviews with representatives from other state DOTs who have been practicing the coordination of various types of work zones.
- Assemble a panel comprised of representatives from the NJDOT who are involved in the work zone decision making process to identify various types of projects put forth by the NJDOT that require short-term or long-term work zones.
- Work closely with the NJDOT contacts to utilize TRANSCOM and its existing regional structure to improve the communication and collaboration in terms of coordinating various repair activities in the region.
- Through one-on-one and/or panel interviews with the identified key personnel, understand the organizational flow within the NJDOT for communicating, collaborating, and scheduling of various types of work zones.
- Determine, through expert interviews with the NJDOT engineers and staff, what type of projects can be coordinated, the anticipated challenges for coordinating various combinations of these projects, and the appropriate steps to eliminate such challenges.
- Collaborate closely with the assembled panel and develop a framework for managing and coordinating work zone projects.
- Develop a user-friendly interface or modify / refine an existing one that will be used to estimate the effectiveness of various combinations of short-term and long-term work zones based on the developed work zone management and coordination framework.
- Explore the use of emerging web-based communication and collaboration technologies that are inexpensive and easy to deploy and maintain. This can be a solution to maintain a contact list of the identified decision makers from the NJDOT and other agencies with the goal of timely sharing information and plans for work zone activities in the region.

3. Description of Work Completed by Task over This Period

PHASE I— Literature Review

This task is completed.

PHASE II

Task 1 — Conduct a Review of Existing Resources

This task is completed.

Task 2 — Determine the Current NJDOT Work Zone Practice

This task is completed.

Task 3 — Develop a Benefit Cost Analysis Process

This task is near completion. The benefits of coordinating work zones are due to reduced vehicular delays, accidents and environmental costs. In order to conduct the benefit cost analysis of coordinating work zones, various datasets are required. The essential dataset when calculating vehicular delays and queues is the hourly volume data at the work zone location. To that end, the research team has worked to obtain the hourly volumes of all major highways and 500 routes.

The research team completed integrating the necessary datasets obtained from the NJDOT. The integrated datasets in the WCS tool were:

(1) ESRI shape file of the New Jersey Straight Line Diagrams (SLD) from the NJDOT in this quarter. The database behind the SLD shape file includes information on the links of major highways and county roads in NJ, such as link length, number of lanes, AADT, zip code, etc.

(2) Short term sensors counts of the last five years. This dataset includes the directional 48-hour duration hourly volumes collected at various highway locations in the state. The dataset shows the sensor ID, direction, begin and end hour of volume counts, and hourly volumes in each direction of traffic flow.

(3) Sensor database. This dataset includes information on all the sensors that are used for collecting hourly volumes on NJ highways. The available information includes sensor ID, sensor type, highway SRI number, sensor milepost, zip code, and X & Y coordinates,

As seen above the necessary data to obtain hourly volumes are available in these three databases. C programming language is used to parse the data and create links between each dataset. AADT information available in the first dataset is converted to hourly volumes.

Through previous studies, research team has economic models for converting vehicular queues into monetary loss in terms of value of time, accident, and environmental costs. The

benefit of coordinating work zones will be realized through reducing the economic costs of vehicular queues.

On the other hand, users can estimate the benefits of rescheduling smaller projects around bigger project and compare this figure with the estimated costs. In this context, the cost of work zone coordination is the "penalty" of delaying one work zone or integrating it into another work zone (consolidation). These numbers are not readily available as they might vary from one work zone to another work zone. During the benefit/cost analysis, this cost estimation will be obtained from the project managers at the NJDOT, since they will have the most accurate numbers.

Benefit cost analysis (BCA) will be implemented in the WCS tool. The idea is to be able to find out the coordination or consolidation of two conflicting projects. Here, a clarification is needed for coordination and consolidation. Consolidation can only happen if two conflicting projects are on the same highway on the same direction within less than a mile apart each other. Coordination includes the cases that do not offer consolidation. Basically, in consolidation instead of having two separate work zones, we combine them into one work zone therefore not impacting traffic twice. This is the benefit of consolidation.

On the other hand, the benefit of coordination is the reduced delay of vehicles. For example, suppose that there are two work zones within the same time period but on different roadways. Let's say there is work zone 1 on road A and work zone 2 on road B. If there were no work zone 2, then vehicles that experience delay on road A would have the option of diverting to road B, therefore reducing their delays. However, since there is another work zone on road B, drivers would be reluctant to do so. If it is coordinated and one of the work zones is rescheduled to another day or time, some vehicles on road A would be able to divert to road B. Therefore, the benefit of coordination is due to the reduced delay of vehicles.

In the WCS tool, let us suppose that the user runs a conflict analysis and find conflicting projects. Then the user is able to click on one of the projects in the conflict list than on top of other options the user should be able to conduct a benefit cost analysis. When clicked on this button, there is a user input box.

A) If the conflict can be averted by **consolidation**, the options in the input box are:

- A drop down menu showing which project will be consolidated (meaning, is Project 1 will be taken in work zone of project 2 or vice versa)
- Number of lanes closed to traffic in the selected project
- Percentage of trucks in traffic in the selected project's work zone
- (if number of lanes closed is zero then) Shoulder closed to traffic (Yes or No)
- (if shoulder closed is YES then) Shoulder width
- Value - of - Time (VOT) for cars (default $18.03 per hour)
- Value - of - Time (VOT) for trucks (default $30.05 per hour)
- Construction time of work zone in hour

Based on the information given, the BCA module will calculate the total delay and total cost for each project. Total cost of each project can be easily calculated using the VOT. For example:

If total delay in project 1 is X, then the total cost of the project can be calculated as:

TC_1 = VOT_car * X* [1-(truck perc/100)] + VOT_truck * X* (truck_per / 100) * total number of WZ hours.

Clearly, when project 1is consolidated into project 2 then the reduction in delay would be TC_1.

B) If the conflict can be averted by **coordination**, the options in the input box would be same as above, except:

The drop down menu shows which project will be coordinated (instead of consolidation)

In addition, there is an input for the diversion rate of vehicles to the other roadway parameter (between 0 and 1). All the parameters inserted by the user are for the project that is NOT being coordinated. For example, if project 1 is coordinated around project 2, then the parameters above will be entered for project 2.

If project 1 is coordinated around project 2 then the total cost will be calculated as follows:

TC_1 = VOT_car * X* [1-(truck perc/100)] + VOT_truck * X* (truck_per / 100) * total number of WZ hours * diversion rate

Since it is difficult to obtain the exact diversion rate from real traffic data or traffic assignment algorithm, the user need select the expected diversion rate based on experience and sensitivity analysis results with different diversion rates.

Task 4 — Develop a Framework for Managing and Coordinating Work Zone Projects

This task is near completion. The proposed two-stage coordination framework is: 1) Stage 1: long-term coordination that coordinates maintenance engineering projects with CPM projects; 2) Stage 2: short-term coordination that coordinates all other work zones.

The research team has completed a historical analysis of completed projects. This approach involves looking back in the past and determines if there were any opportunities for work zone coordination, and determines the benefit and costs of coordination accordingly. To that end, the research team has obtained the list of maintenance and CPM projects between 2012 and 2013. Also, the research team has also obtained the historical OpenReach database. This database contains all events including information on historical work zones such as the time and date of work zone, how many lanes were closed, work zone description, type of project, etc. It was proposed that by combining the list of historical maintenance and CPM projects and the historical OpenReach database, the research team could pinpoint cases where coordination could have been beneficial for road users and the NJDOT.

However, it was determined that matching the maintenance projects in the CPM tool is not a straightforward task. The research team found many maintenance projects in the OpenReach database that do not appear in the list, and there are many cases where the maintenance projects included in the list do not appear in the OpenReach database. The research team has tried computer coding to do this automatically; however, it was not satisfactory. This process took longer time than expected.

Therefore, it was decided to conduct this analysis manually. To that end the research team identified conflicting projects using the OpenReach database only. We identified about 100 conflicts on 10 different roadways by manually checking the database. Figure 1 shows the potential conflicting work zones identified on Route 1 using the historical OpenReach database.

WCS tool will be used to estimate the benefits and costs of coordinating or consolidating these conflicting projects.

US 1

Workzone1	Workzone2	Hours Overlapped	Mile Difference	Description1	Description2	Wz1 Create Time	Wz1 Close Time	Wz2 Create Time	Wz2 Close Time	Lane Information for WZ1	Lane Information for WZ2
48963301	48964401	5	2.9	'NJ DOT - TOC South: Construction steel repair	'NJ DOT - TOC South: Construction tree trimming c	'2013-04-04 09:00'	'2013-04-04 15:19'	'2013-04-04 09:00'	'2013-04-04 14:30'	right shoulder closed	right shoulder closed
50410701	50410901	8	4.7	'NJ DOT - STMC: Construction guard rail repair	'NJ DOT - STMC: Construction bridge construction	'2013-04-25 21:00'	'2013-04-26 06:03'	'2013-04-25 21:00'	'2013-04-26 05:01'	ramp closed	1 to 2 lanes closed
50891401	50893201	8	4.8	'NJ DOT - STMC: Construction construction on	'NJ DOT - STMC: Construction bridge work on US 1	'2013-05-02 21:00'	'2013-05-03 06:02'	'2013-05-02 21:00'	'2013-05-03 05:02'	ramp closed	left lane closed
52261301	52263001	5	8.1	'NJ DOT - TOC South: Construction roadwork o	'NJ DOT - TOC South: Roadwork roadwork on US 1	'2013-05-22 09:00'	'2013-05-22 15:00'	'2013-05-22 09:13'	'2013-05-22 15:43'	N/A	left lane closed
57716401	57716501	5	4.5	'NJ DOT - TOC South: Construction guard rail re	'NJ DOT - TOC South: Construction guard rail repai	'2013-08-14 09:01'	'2013-08-14 15:00'	'2013-08-14 09:01'	'2013-08-14 15:00'	left lane closed	right shoulder closed
57716401	57716501	5	4.5	'NJ DOT - TOC South: Construction guard rail re	'NJ DOT - TOC South: Construction guard rail repai	'2013-08-14 09:01'	'2013-08-14 15:00'	'2013-08-14 09:01'	'2013-08-14 15:00'	left lane closed	right shoulder closed
58720001	58730501	6	8.1	'NJ DOT - STMC: Construction utility work on U	'NJ DOT - STMC: Construction bridge work on US 1	'2013-08-29 08:00'	'2013-08-29 15:02'	'2013-08-29 09:00'	'2013-08-29 15:02'	right shoulder closed	1 lane may be closed
58720001	58730501	6	8.1	'NJ DOT - STMC: Construction utility work on U	'NJ DOT - STMC: Construction bridge work on US 1	'2013-08-29 08:00'	'2013-08-29 15:02'	'2013-08-29 09:00'	'2013-08-29 15:02'	right shoulder closed	1 lane may be closed
59075101	59097801	5	3	'NJ DOT - TOC South: Construction crack sealin	'NJ DOT - TOC South: Emergency construction and	'2013-09-05 09:00'	'2013-09-06 14:03'	'2013-09-05 17:07'	'2013-09-05 22:46'	left lane closed	right lane closed
59645001	59673501	22	0.2	'NJ DOT - STMC: Construction intersection imp	'NJ DOT - STMC: Construction construction on US :	'2013-09-13 16:23'	'2013-09-25 14:16'	'2013-09-14 00:00'	'2013-09-14 22:45'	partial ramp closed	right shoulder closed
61733601	61733901	8	9.6	'NJ DOT - TOC South: Construction constructio	'NJ DOT - STMC: Construction drainage improvem	'2013-10-15 20:01'	'2013-10-16 05:00'	'2013-10-15 20:01'	'2013-10-16 06:01'	2 right lanes closed	right and center lanes closed
61831301	61831501	9	9.6	'NJ DOT - TOC South: Construction constructio	'NJ DOT - STMC: Construction drainage improvem	'2013-10-16 20:00'	'2013-10-17 05:01'	'2013-10-16 20:00'	'2013-10-17 06:02'	2 right lanes closed	right and center lanes closed
62566301	62584801	6	2.5	'NJ DOT - STMC: Construction construction on	'NJ DOT - STMC: Construction construction on US :	'2013-10-28 07:00'	'2013-10-28 15:32'	'2013-10-28 09:01'	'2013-10-28 15:01'	right shoulder closed	right lane closed
67163501	67179601	0	0.2	'NJ DOT - TOC South: Construction guard rail re	'NJ DOT - STMC: Unanticipated Construction Delay	'2014-01-20 09:00'	'2014-01-20 15:00'	'2014-01-20 14:57'	'2014-01-20 15:24'	right lane closed	right lane closed
70566601	70566901	2	3.3	'NJ DOT - STMC: Construction moving operatio	'NJ DOT - TOC South: Construction construction or	'2014-03-24 21:00'	'2014-03-25 02:01'	'2014-03-24 21:00'	'2014-03-24 23:00'	1 to 2 lanes closed	right lane closed
71135901	71136101	0	1.5	'NJ DOT - STMC: Construction moving operatio	'NJ DOT - STMC: Construction moving operation or	'2014-04-02 21:00'	'2014-04-02 21:05'	'2014-04-02 21:00'	'2014-04-03 05:01'	1 to 2 lanes closed	1 to 2 lanes closed
71136101	71142101	6	2.8	'NJ DOT - STMC: Construction moving operatio	'NJ DOT - STMC: Construction moving operation or	'2014-04-02 21:00'	'2014-04-03 05:01'	'2014-04-02 23:00'	'2014-04-03 05:03'	1 to 2 lanes closed	right shoulder closed
72324701	72329801	4	6.7	'NJ DOT - STMC: Construction moving operatio	'NJ DOT - TOC South: Construction traffic signal rej	'2014-04-22 09:01'	'2014-04-22 15:01'	'2014-04-22 10:00'	'2014-04-22 14:01'	1 lane closed	N/A
73875701	73875801	0	0	'NJ DOT - STMC: Construction construction on	'NJ DOT - STMC: Construction bridge maintenance	'2014-05-14 20:00'	'2014-05-14 20:28'	'2014-05-14 20:00'	'2014-05-15 06:02'	2 right lanes closed	right and center lanes of 3 lanes closed

Figure 1. Potential conflicting work zones identified in the historical OpenReach database

Task 5 — Develop an Interface for Work Zone Coordination and Management

This task is ongoing. Within the last quarter the research team has made significant improvements to the WCS tool. The program was modified to include all active and historical maintenance and CPM projects. The improvements included (1) Project Visualization: Users can filter projects based on various criteria, such as project status, SRI number, time frame, milepost range, county, project manager, and structure. Users can also view project timeline as a Gantt chart. (2) Conflict Analysis: Once the WCS tool determines the list of projects that are in conflict with any selected project, users can click on a conflicting project from the list and view a Gantt chart that show the project timeliness of both project on the same chart. This is the time-based conflict. As per the spatial conflict, both projects are shown on a smaller map.

In this quarter the research team added the benefit cost analysis module in the WCS tool. This module works based on the proposed benefit cost analysis framework explained in Task 3. When users find conflicting projects with a given project, they can simply select a conflicting project from the list (as shown in Figure 2). Once selected, the users can view the project timeline in a Gantt chart. In the Gantt chart there is a link to conduct a benefit cost analysis for coordination / consolidation of these two projects (See Figure 3). When clicked it brings up an input box with all parameters needed to conduct a benefit cost analysis, as shown in Figure 3.

In the next quarter the research team will input the conflicting projects identified in Task 3 and estimate the benefits of coordinating / consolidating the conflicting projects using the benefit cost analysis module.

Figure 1. List of Conflicting Projects

Figure 2. Benefit Cost Analysis Link in a Gantt Chart

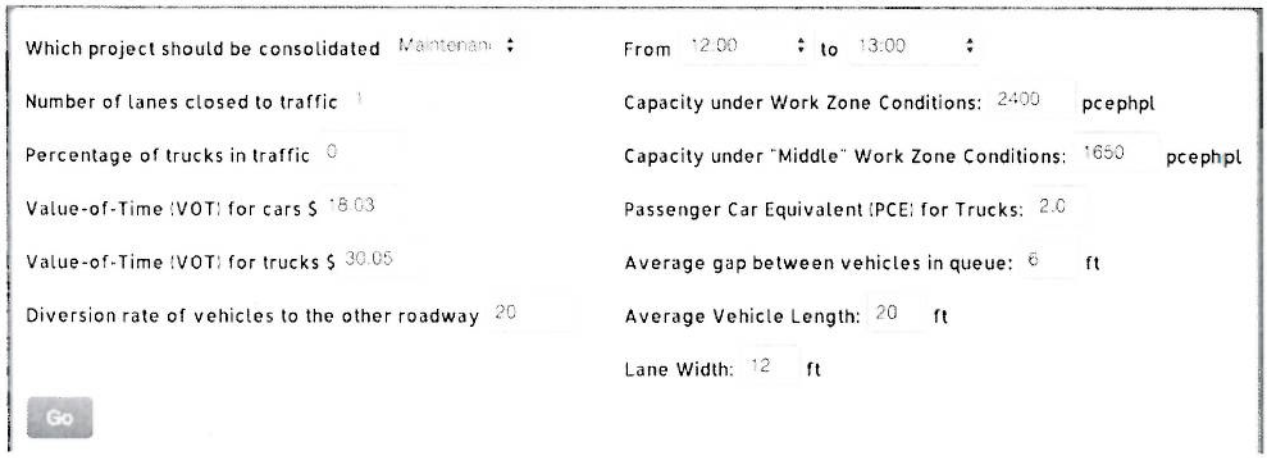

Figure 3. Cost Benefit Analysis Module in WCS Tool

Task 6— Training and Technology Transfer

- N /A

Task 7 — Project Management, Final and Quarterly Reports

- 1st quarter report was compiled and submitted in December 2012
- 2nd quarter report was compiled and submitted in March 2013.
- 3rd quarter report was compiled and submitted in June 2013.
- 4th quarter report was compiled and submitted in September 2013.
- 5th quarter report was compiled and submitted in January 2014.
- 6th quarter report was compiled and submitted in April 2014.
- 7th quarter report was compiled and submitted in June 2014.
- 8th quarter report was compiled and submitted in September 2014.

4. Proposed activities for next quarter by task:

Task 1 — Conduct a Review of Existing Resources

- N/A

Task 2 — Determine the Current NJDOT Work Zone Practice

- N/A

Task 3 — Develop a Benefit Cost Analysis Process

- The research team will finalize combining the benefit cost analysis methodology in the WCS tool.

Task 4 — Develop a Framework for Managing and Coordinating Work Zone Projects

- The research team will test the BCA module of the WCS tool using the historical project information obtained from the OpenReach database.

Task 5 — Develop an Interface for Work Zone Coordination and Management

- The research team will improve the WCS tool based on the feedback and comments from the NJDOT personnel.

Task 6— Training and Technology Transfer

- The research team will demo the WCS tool to the NJDOT personnel for testing.

Task 7 —Project Management, Final and Quarterly Reports

- The research team will submit a quarterly report for the December meeting.

5. List of deliverables provided in this quarter by task:

- An improved beta version of the WCS tool.

6. Progress on Implementation and Training Activities:

- N/A

7. Problems/Proposed Solutions:

- The research team is trying to identify NJDOT personnel to test the developed tool and there is delay in this process especially due to the change of the NJDOT project

contact. However, in the next quarter we are hoping to resolve this issue with our new contact.

8. Project Summary:

Authorized Project Budget (Year 1)	$	168,488.40
Total Project Budget (Years 1&2)	$	321,819.12
Total Project Expenditure to date	$	241,919.60
% of Total Project Budget Expended		75.17%

NJDOT Research Project Manager Concurrence: _____ Date: 10/09/2014