RUTGERS

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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 / Dr. Kaan Ozbay
Project Starting Date: 9/17/2012 Project Ending Date: 9/17/2014 Proposed Modified Ending Date: 06/30/2015	Period Starting Date: 04/01/2014 Period Ending Date: 06/30/2014

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	10%	$3,293.98	70%	$23,057.86
4	Develop a Framework for Managing and Coordinating Workzone Projects	27.38%	$ 88,121.32	10%	$8,812.13	70%	$61,684.92
5	Develop an Interface for Work Zone Coordination and Management	29.76%	$ 95,787.85	15%	$14,368.18	50%	$47,893.93
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	15%	$3,563.62	60%	$14,254.50
Total		**100%**	**$321,819.12**	**9.33%**	**$30,037.91**	**61.35%**	**$197,437.72**

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. Rutgers team reviewed numerous resources including the FHWA Best Practices Guidebook and several NCHRP reports, which have the latest efforts of coordinating work zone activities and improving communication.

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.

Within this quarter the research team met with various NJDOT staff. The following table shows the meeting dates and the names of the NJDOT staff.

Name	Date
Ahmad Ghorbani	April 21, 2014
Jeevanjot Singh	April 21, 2014
Jim Hadden	June 18, 2014
Sheryl Grant	June 20, 2014

Task 3 — Develop a Benefit Cost Analysis Process

This task is ongoing. 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.

For this purpose, the research team has obtained several datasets from NJDOT. These are:

(1) ESRI shape file of the New Jersey Straight Line Diagrams (SLD) from 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 using the following formula:

Hourly Volume [i] = **AADT** ***Directional Flow** [i] * **Hourly Distribution** [i]

Where, i stands for hour of the day, i = 1… 24

The C program coded by the research team finds the closest sensor to each highway link using the links between each dataset, and determines the directional flow and hourly distribution, and calculates hourly volume. For instance, if we would like to determine the hourly volume for a given segment on Route 1 from the first database, then the C code determines the closest sensor ID from the third database. Following that, hourly distribution and directional flow factors are obtained from the second database using the sensor ID.

So far, the research team has calculated the hourly volumes for each highway segment in the first database. This information is input in the WCS tool. Availability of such a rich dataset enables us to calculate the resulting queue formation when one or more lanes are closed to traffic due to a scheduled work zone. Similarly, the tool can estimate the vehicle delays and costs associated with a planned work zone. The queue length and vehicle delay calculations are adopted from a previous NJDOT research study conducted by the team members. In that project, the work zone queue estimation tool RILCA was developed to estimate queue lengths and delays. Similar calculations will be used in the WCS tool to determine the congestion impacts of work zones. In addition, WCS tool will also estimate the accident and environmental costs of a scheduled work zone.

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.

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

This task is still ongoing. The proposed approach of two-stage coordination framework will be used: 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 crucial point for the proposed approach is the extended database of CPM projects and maintenance operations projects. Last quarter, the research team had obtained the list of maintenance engineering projects that are planned to be contracted out in 2014. These include roadway repair, drainage restoration, roadway sweeping, job order contracting of bridge repairs, bridge preventive maintenance, crack sealing and restriping contracts. This information is input in the WCS tool. In addition, within this quarter the research team has also obtained the database of CPM projects, and these were imported in the WCS tool.

However, we do not have any detailed scheduling information on the maintenance projects that are planned to be contracted out in 2014. In other words, it is known that these projects will be carried out; yet the information on when and what days they will be working on the roadway, how many lanes will be closed are unknown until they request permission from Traffic Operations one month before the work zones starts.

Therefore, the research team has devised an historical analysis of completed projects. This approach involves looking back in the past and finding if there were any opportunities for work zone coordination, and determine 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. (See Figure 1).

Event ID	Facility Name	Created At Date Time	Closed At Date Time	Event Type	Event Description
44101104	CR 537/Marne Hwy/Monmouth Road	1/2/13 9:00	1/2/13 15:00	Construction	Burlington County TOC: 015 installation of conduits and installation of traffic management systen 537/Marne Hwy/Monmouth Road both directions between Coles Avenue (Maple Shade Twp) anc 608/Lenola Road (Moorestown Twp) , Tuesday November 27th, 2012 thru Thursday December 27 Monday thru Friday, 09:00 AM thru 03:30 PM, 1 1 lane may be of 2 lanes closed intermittently
44101204	CR 615/ Marlier Ave	1/2/13 9:00	1/2/13 15:00	Construction	Burlington County TOC: Construction, utility work on CR 615/ Marlier Ave southbound between C Centerton Road (Moorestown Twp) and CR 573/ E Main Street (Moorestown Twp) 2 1 lane of 2 l closed to traffic until 3:00 P.M.
44101401	NJ 79	1/2/13 9:01	1/2/13 15:00	Construction	NJ DOT - TOC South: Construction, roadwork on NJ 79 southbound South of CR 3/Lloyd Rd (Marlb right shoulder closed for repairs until 3:00 P.M.
44103501	NJ 70	1/2/13 12:00	1/2/13 15:00	Construction	NJ DOT - TOC South: Construction, construction on NJ 70 eastbound West of Garden State Parkwa (Lakewood Twp) to Shorrock St (Lakewood Twp) deceleration lane closed until 3:00 P.M.
44103701	NJ 3	1/2/13 12:00	1/2/13 15:01	Construction	NJ DOT - STMC: Construction, guard rail repairs on NJ 3 both directions between Garden State Pa (Clifton) and NJ 495 (North Bergen Twp) left lane closed for repairs until 3:00 P.M.
44101801	NJ 49	1/2/13 9:19	1/2/13 15:02	Construction	NJ DOT - TOC South: Construction, drainage improvements on NJ 49 westbound East of NJ 45 (Sal shoulder closed until 3:00 P.M.
44102507	George Washington Bridge	1/2/13 9:29	1/2/13 15:02	Construction	Port Authority NY/NJ: Construction on George Washington Bridge westbound Mid Span/Lower Le (Manhattan) right lane blocked until 3:00 P.M.
44097007	Bayonne Bridge	1/2/13 7:33	1/2/13 15:03	Construction	Port Authority NY/NJ: Construction on Bayonne Bridge northbound between New York Side (State and New Jersey Side (Bayonne) 1 lane closed until 3:00 P.M.
44103001	US 1&9 Truck Route	1/2/13 10:02	1/2/13 15:12	Watermain break	NJ DOT - STMC: Watermain break on US 1&9 Truck Route southbound Broadway (Jersey City) all open to traffic
44101704	CR 607/Cinnaminson Ave/Church St/Maple Ave	1/2/13 9:18	1/2/13 15:18	Construction	Burlington County TOC: Construction, bridge construction on CR 607/Cinnaminson Ave/Church St Ave both directions between Gaither Drive (Mount Laurel Twp) and CR 612/Elbo Lane (Mount La 2 of 4 lanes closed to traffic until 3:00 P.M.
44091601	NJ 36	1/2/13 7:00	1/2/13 15:30	Construction	NJ DOT - TOC South: Construction, construction on NJ 36 both directions CR 11/Oceanport Av (W Branch) to North of Long Branch Av (Long Branch) right shoulder closed until 3:30 P.M.
44091701	NJ 71	1/2/13 7:00	1/2/13 15:30	Construction	NJ DOT - TOC South: Construction, construction on NJ 71 southbound North of Roosevelt Av (Long to South of Cedar Av (Long Branch) right shoulder closed until 3:30 P.M.
44101301	US 9	1/2/13 9:00	1/2/13 15:31	Construction	NJ DOT - TOC South: Construction, utility work on US 9 southbound Bay Pkwy (Ocean Twp) right s closed until 3:30 P.M.
44116204	CR 541/High St/Mt Holly Bypass/Stokes Rd	1/2/13 15:32	1/2/13 15:38	Accident with Injuries	Burlington County TOC: Accident with Injuries on CR 541/High St/Mt Holly Bypass/Stokes Rd sout CR 630/Woodlane Road (Westampton Twp) 2 all lanes of 2 lanes closed and detoured
44099101	Garden State Parkway	1/2/13 8:06	1/2/13 15:48	Roadwork	NJ Turnpike Auth.: Roadwork on Garden State Parkway southbound North of Exit 98 NJ 138 (Wa North of Exit 91 - CR 549/Chambers Bridge Road (Brick Twp) right lane closed to traffic until 3:00
44116401	NJ 20	1/2/13 15:36	1/2/13 15:51	Accident	NJ DOT - STMC: Accident on NJ 20 northbound To NJ 4 (Paterson) left lane blocked
44104401	NJ 42	1/2/13 15:19	1/2/13 15:51	Accident	NJ DOT - TOC South: Accident on NJ 42 southbound approaching Atlantic City Expressway (Washi Twp) right shoulder closed use caution
44091401	Garden State Parkway	1/2/13 6:56	1/2/13 15:54	Roadwork	NJ Turnpike Auth.: Roadwork on Garden State Parkway northbound North of New Gretna Toll Pla River Twp) left lane closed to traffic until 2:00 P.M.
44102701	Garden State Parkway	1/2/13 9:36	1/2/13 15:55	Roadwork	NJ Turnpike Auth.: Roadwork on Garden State Parkway northbound South of Exit 83 US 9 North River Twp) to North of Toms River Toll Plaza (Toms River Twp) left lane closed to traffic until 3:0

Figure 1. OpenReach Database

Combining the list of historical maintenance and CPM projects and the historical OpenReach database, the research team will pinpoint cases where coordination could have been beneficial for road users and the NJDOT. The WCS tool will be used to estimate the benefits and costs of work zone coordination.

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

This task is ongoing. Within this quarter the research team has made improvements to the WCS tool. Right now, the program includes all active and historical maintenance and CPM projects. The improvements include:

(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 (See Figure 2). Users can also view project timeline as a Gantt chart.

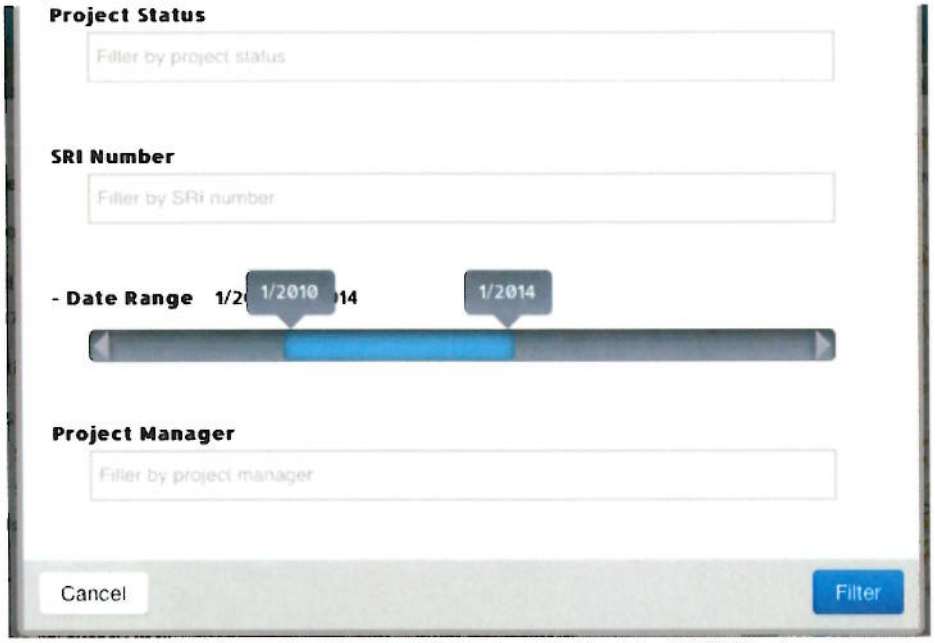

Figure 2. Advanced Filtering Options in WCS Tool

(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 (See Figure 3). This is the time-based conflict. As per the spatial conflict, both projects are shown on a smaller map.

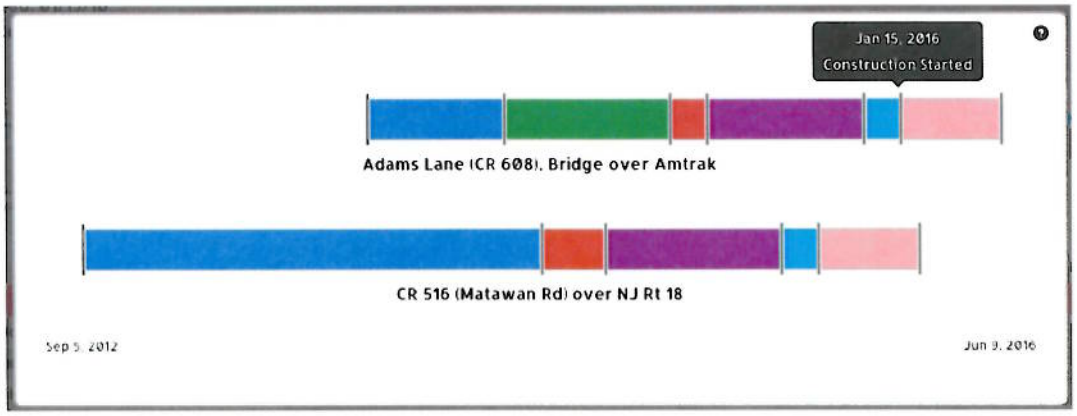

Figure 3. Gantt Chart of Conflicting Projects

The research team presented the WCS tool to Sheryl Grant at the NJDOT on June 20, 2014 and incorporated her feedback and suggestions in the new version of the 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.

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, in collaboration with the Maintenance and Traffic Operations, the feasibility of using the WCS tool with the historical project information obtained from Maintenance Operations and CPM.

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

- N /A

Task 7 —Project Management, Final and Quarterly Reports

- The research team will submit a quarterly report for the September 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:

- This project required reaching out to various units of NJDOT dealing with different types of construction projects. The coordination of these efforts caused delays.
- The need for extensive project and traffic data from the above NJDOT units was another reason of delay. Each DOT unit was asked to provide data that had to be extracted.
- The construction and traffic data from multiple sources are now available. However, the research team is now processing, cleaning and analyzing the data. This extensive effort also requires additional time.
- Due to the size and complexity of the new integrated dataset, the research team has to develop a user friendly data visualization tool which also requires more time than planned.
- The research team was also able to obtain historical project data that was not planned originally but will allow the research team to validate the proposed approach in a very

robust way. This will be part of evaluation work for the developed tool but it will require a couple of extra months to achieve.

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	$	197,437.72
% of Total Project Budget Expended		61.35%

NJDOT Research Project Manager Concurrence: L Rashid Date: 07/10/2014