Feasibility Study on Implementation of CA4PRS in Oklahoma

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Outline

- Introduction
- CA4PRS Workshop
- Case Studies
- Resource Profile Information
- Development of a Model for Resource Profile Information
- Limited Number of Activities
- Conclusions

Introduction

Roads Condition in Oklahoma

- 40% of Oklahoma's major roads are rated in poor or mediocre condition (ASCE 2009).
- Costs Oklahoma motorists $1 billion a year in extra vehicle repairs and operating costs (OTC 2009).
- Total projected revenues from FY2009 to FY2028 amount to 39 percent of needs, resulting in a shortfall of $16.9 billion (ODOT 2009).
- Urgent need to improve management strategies; minimize the costs and optimize rehabilitation activities.

OBJECTIVES

- Study the feasibility of using CA4PRS for PCC pavement rehabilitation projects in Oklahoma.

CA4PRS Workshop

CA4PRS One day Workshop

- Date: April 13, 2010
- Instructor: Dr. E.B. Lee
- Participants: ODOT Engineers
- Survey Topics:
  - General knowledge of the program
  - Applicability to ODOT operations
  - Potential for improvement of process
  - Availability of information
  - Usability of the program

CA4PRS One day Workshop

- Questionnaire ›

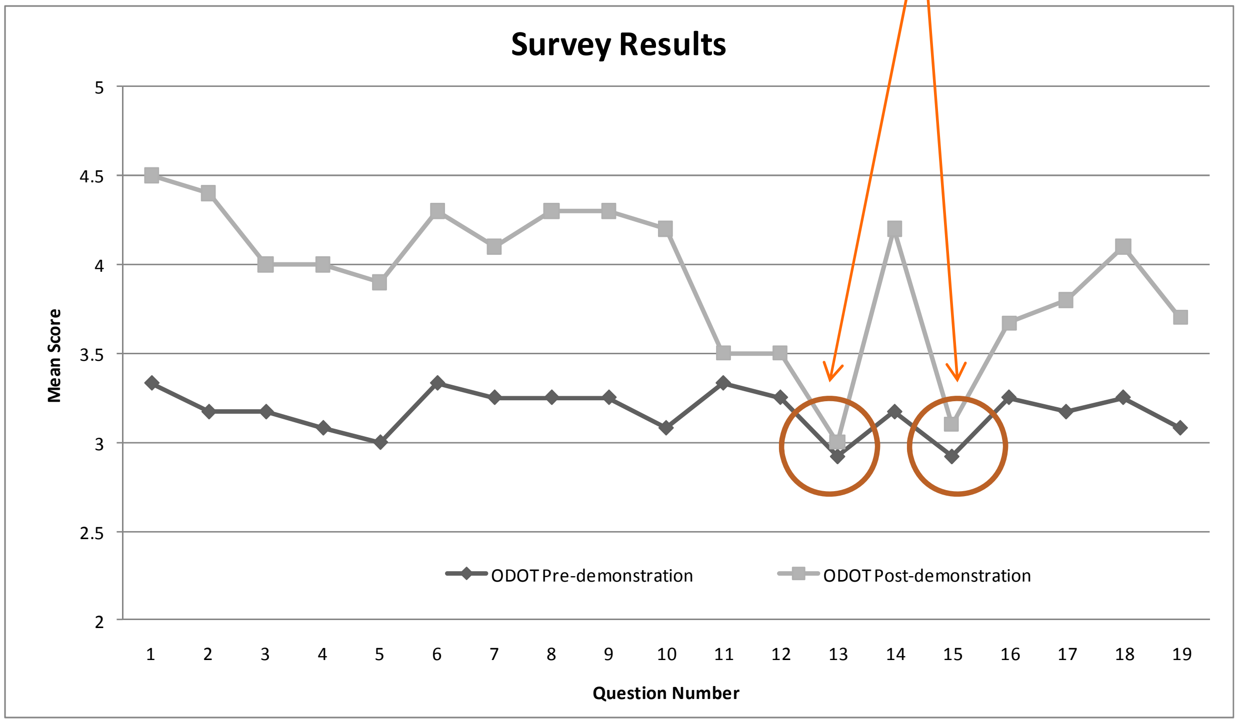
Oklahoma State University
Georgia Institute of Technology
Evaluation of Construction Strategies for PCC pavements
CA4PRS Knowledge Inventory and Opinion Survey
April 13th, 2009 (pre-demonstration)

The purpose of this short questionnaire is to assess your understanding of the concepts presented in the CA4PRS demonstration and to obtain your opinion on the implementation of CA4PRS at the Oklahoma Department of Transportation.

Indicate your level of agreement with the following statements.	*Strongly Agree*	*Agree*	*Not sure*	*Disagree*	*Strongly Disagree*
	5	*4*	*3*	*2*	*1*
CA4PRS is a scheduling and traffic analyisis tool.	☐	☐	☐	☐	☐
CA4PRS is used to select the most economical strategies for highway rehabilitation given variuos project constraints.	☐	☐	☐	☐	☐
CA4PRS will allow ODOT to comply with FHWA Rule 23 CFR Part 630 Subpart J.	☐	☐	☐	☐	☐
The use of CA4PRS will allow ODOT to improve safety in work zones.	☐	☐	☐	☐	☐
The use of CA4PRS will improve constructability of ODOT's new roadway projects.	☐	☐	☐	☐	☐
The use of CA4PRS will improve constructability of ODOT's roadway rehabilitation projects.	☐	☐	☐	☐	☐
CA4PRS is applicable for asphalt pavement construction and/or rehabilitation in Oklahoma	☐	☐	☐	☐	☐
CA4PRS is applicable for Jointed Plane Concrete Pavement (JPCP) construction and/or rehabilitation in Oklahoma.	☐	☐	☐	☐	☐
CA4PRS is applicable for Continuously Reinforced Concrete Pavement (CRCP) construction and/or rehabilitation in Oklahoma.	☐	☐	☐	☐	☐
CA4PRS is applicable to the way lane closures are implemented in Oklahoma.	☐	☐	☐	☐	☐
ODOT has readily available information regarding mobilization and demobilization durations.	☐	☐	☐	☐	☐
ODOT has readily available schedule logic relationship information (for example, finish-to-start) for paving activities.	☐	☐	☐	☐	☐
ODOT has readily available contractor resource information (number of trucks, capacity of batch plants, speed and number of paving machines, etc.).	☐	☐	☐	☐	☐
CA4PRS is a useful tool for analysis of staging alternatives in Oklahoma.	☐	☐	☐	☐	☐
ODOT has the necessary data to make use of CA4PRS without substantial changes to current practices.	☐	☐	☐	☐	☐
I feel that I can learn to use CA4PRS on my own.	☐	☐	☐	☐	☐
I feel that I will be more productive in my job by using CA4PRS.	☐	☐	☐	☐	☐
CA4PRS can improve communication between the various project participants at ODOT.	☐	☐	☐	☐	☐
CA4PRS can easily be integrated into the current ODOT project development process.	☐	☐	☐	☐	☐

Survey Results

Q13, Q15



Interpretation of Results

- A general increase (approximately 20%) in the level of agreement with the potential applicability of the program for analysis of procedures used in Oklahoma.
- A general increase in the level of agreement of participants with the idea that CA4PRS could improve ODOT current practices.
- Participants have been consistent with their perception that ODOT does not have the readily available input information to run CA4PRS (Q13, Q15).

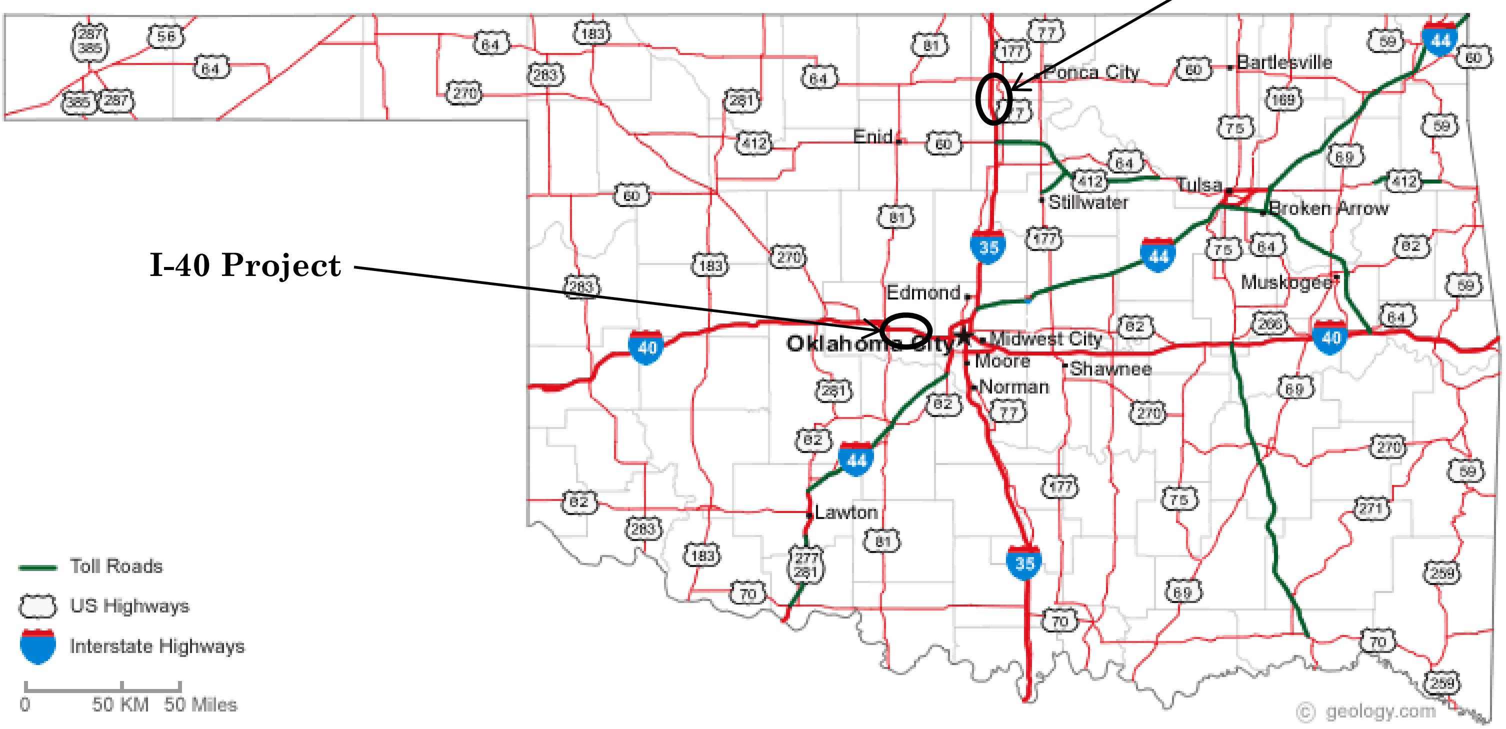
Case Studies

Case Projects

- Two PCC pavement rehabilitation projects studied (I-35 & I-40)
- I-35 is finished / I-40 is ongoing

I-35 Project

I-40 Project



Source: http://geology.com/state-map/oklahoma.shtml

I-35 Scheduling & Traffic Analysis

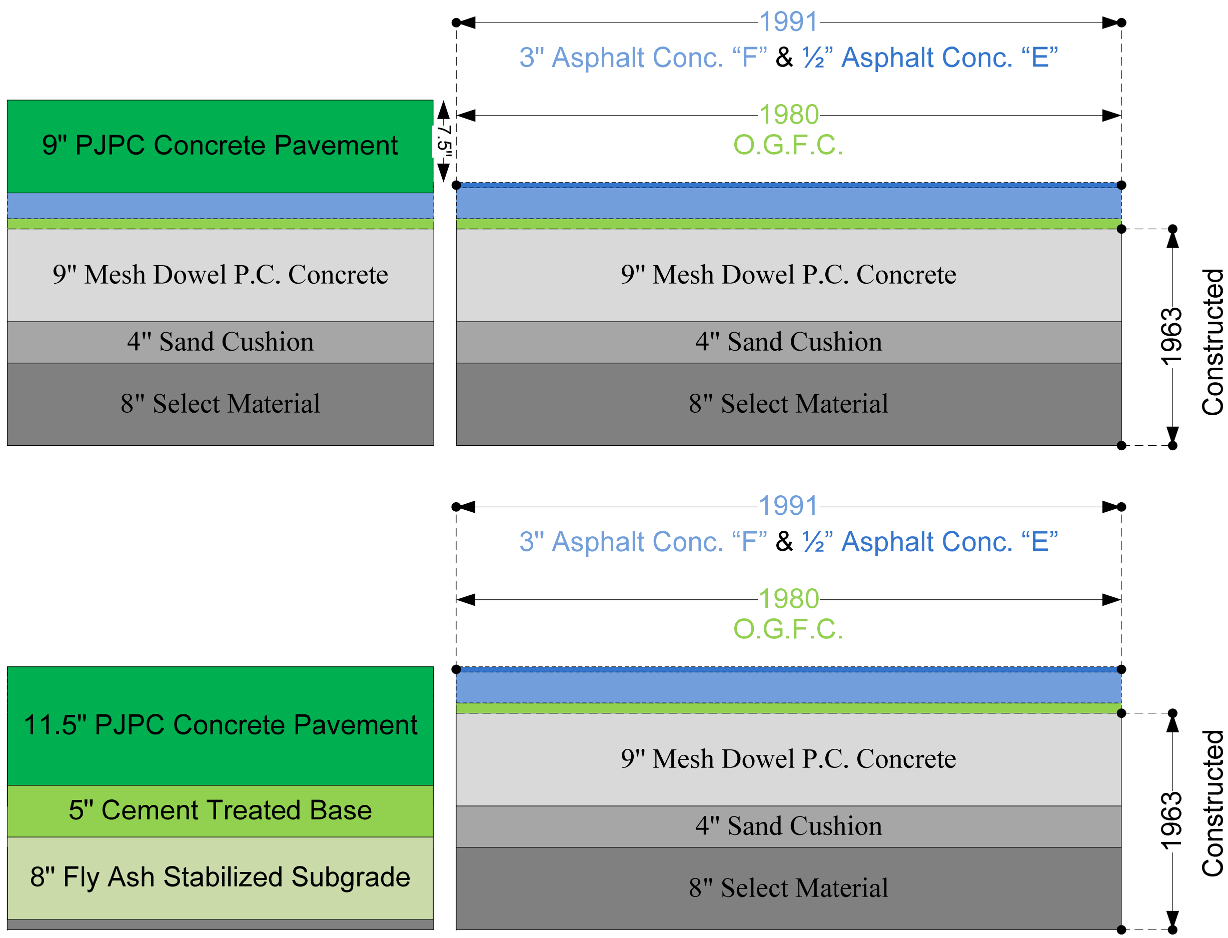
Project Overview

- North-South Interstate highway
- Two lanes in each direction
- Project starts from the mile post of 197 and ends in the mile post of 204

Rehabilitation Profile

Unbonded Concrete Overlay

Full Depth



Rehabilitated Pavement

Existing Pavement

Contractual Features

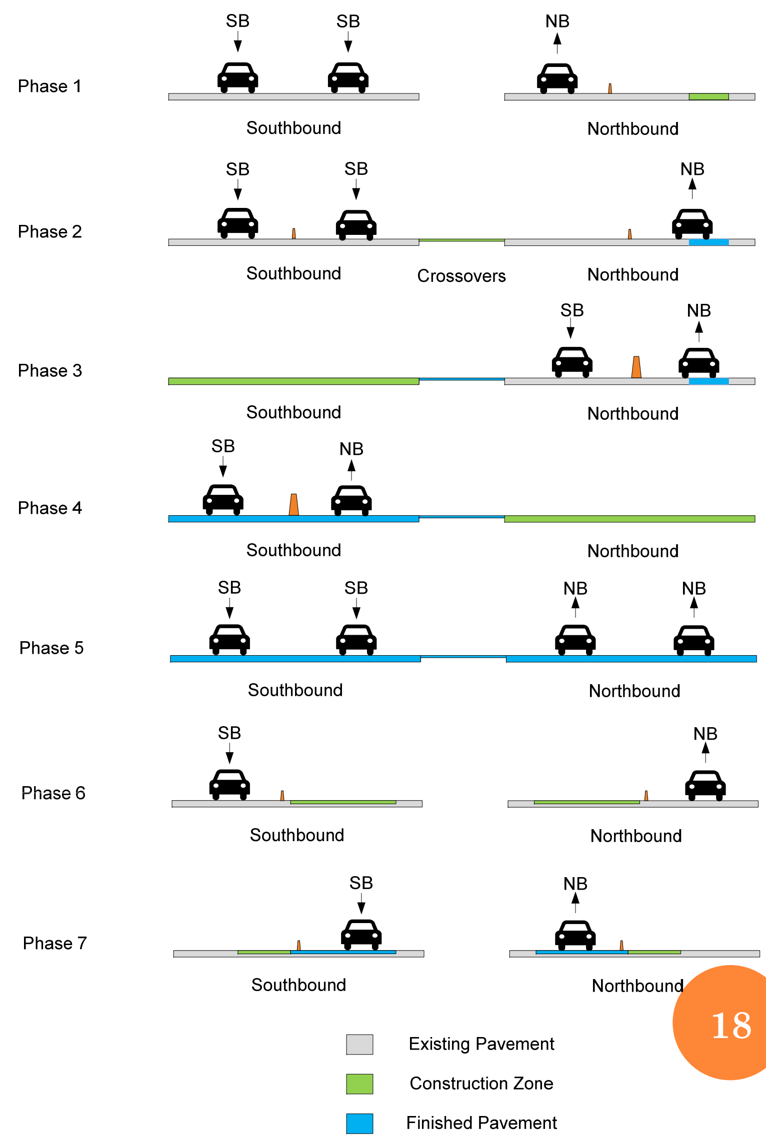
- A+B Contract; A=$13.1 M & B=275 c-days
- Incentive/Disincentive → $7,500/c-day
- Incentive Cap → 90 c-days
- Started on August 2009
- Finished on May 2010
- Actual Duration → 275 c-days

Problems faced during analysis

- The project had to be divided into different phases in order to be modeled by CA4PRS.
- Resource profile information had to be collected by performing regular site visits.
- Neither ODOT nor contractors had information regarding Mobilization, Demobilization, and lead lag times.

PHASING PLANS

- Phase 1: 6’ concrete temporary shoulder
- Phase 2: Construct X-overs
- Phase 3: 2x12’+1x14’ Overlay & Full Depth
- Phase 4: 2x12’+1x14’ Overlay & Full Depth
- Phase 5: Open lanes
- Phase 6: 2x12’ inside lanes mill & overlay
- Phase 7: 2x12’ outside lanes mill & overlay



Analysis & Results

Phase	Description	Duration (working days)	User cost ($)
1	NB temporary shoulder	15	51,108
2	Pave crossovers	5	14,720
3&4, Section 1	SB & NB Concrete overlays	47	176,736
3&4, Section 2	SB & NB full depth reconstruction	85	498,027
6&7	Mill and overlay	4	23,552
8	Other activities	38	322,869
Total		**194**	**1,087,012**

•Considering 15% expansion; the final suggested duration for this project would be 230 working days or 316 c-days.

•Has been scheduled and finished by the contractor in 200 working days or 275 c-days.

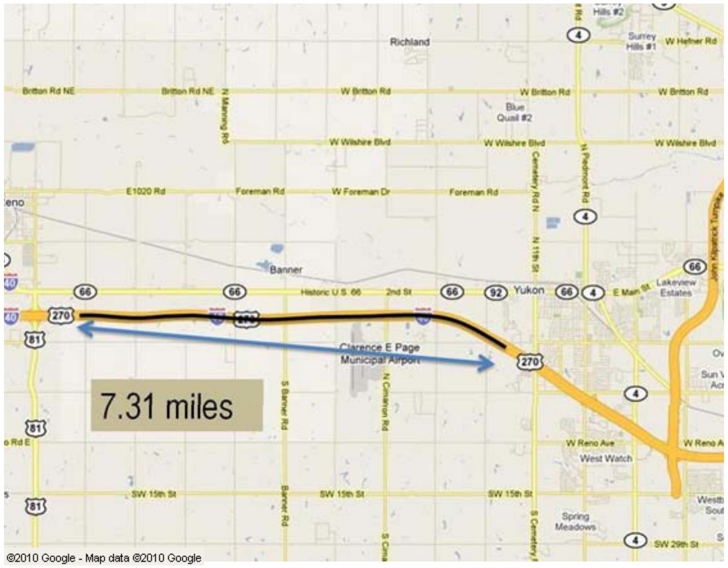
•Actual productivity rate of the project was higher than CA4PRS calculations.

•User cost per c-day = $4,000 < Actual Incentive = $7,500 / c-day

I-40 Scheduling & Traffic Analysis

Project Overview

- West-East Interstate highway
- Two lanes in each direction
- Project starts from the mile marker 125 to mile marker 136.
- Still on going



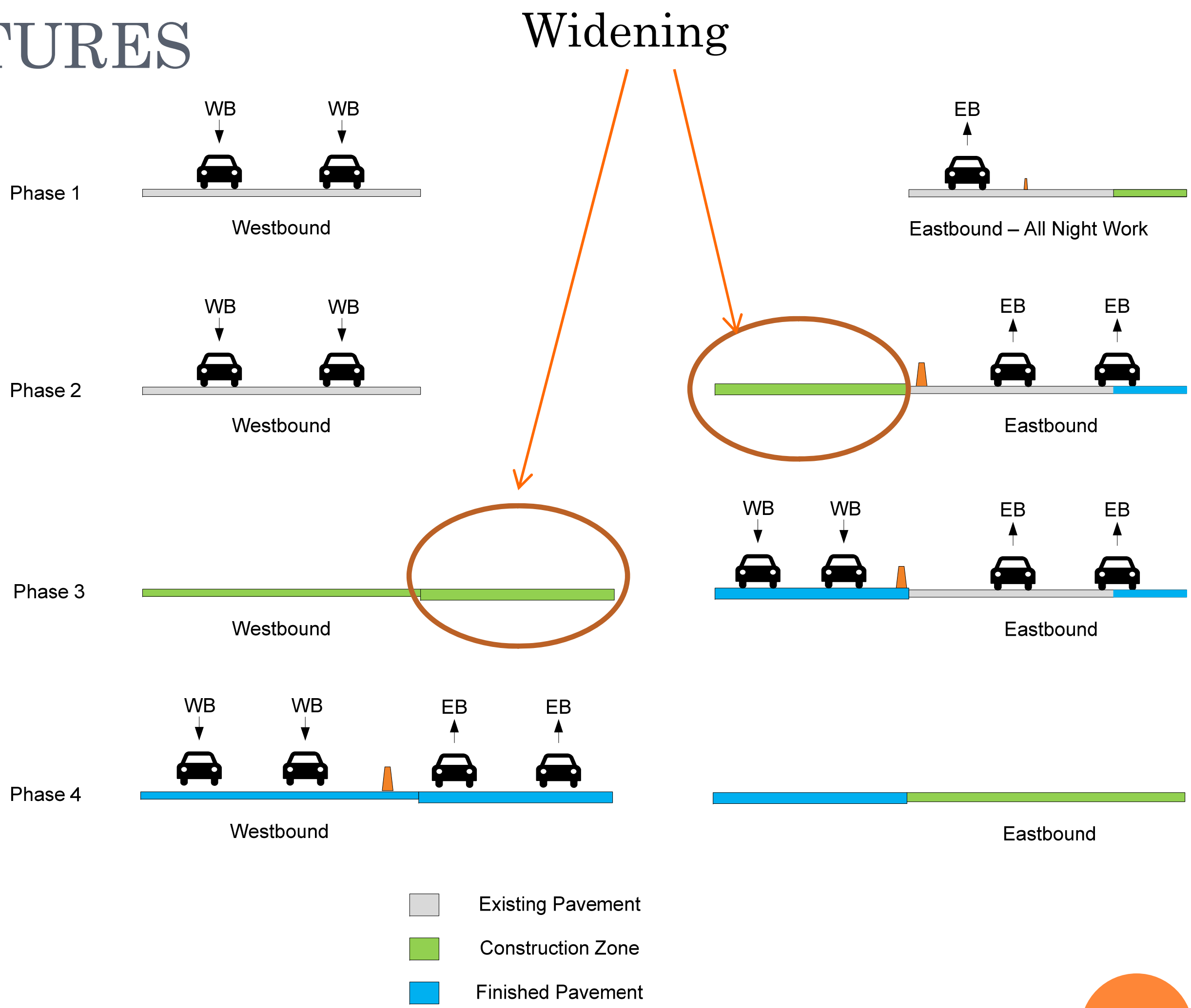
Contractual Features

- A+B Contract; A=$59 M & B=800 c-days
- Incentive/Disincentive → $15,000/c-day
- Incentive Cap → 150 c-days
- Liquidated damage →$2,000/c-day
- Lane Rental Fee → $30,000/hour

Time	Monday thru Friday	Saturday	Sunday
12 am - 6 am	$0	$0	$0
6 am - 9 am	$30,000	$0	$0
9 am - 12 pm	$30,000	$0	$0
12 pm - 6 pm	$30,000	$30,000	$30,000
6 pm - 9 pm	$30,000	$30,000	$0
9 pm - 12 am	$0	$0	$0

UNIQUE FEATURES

- Phase 1: 10' concrete temporary shoulder
- Phase 2: 28' EB widening
- Phase 3: Reconstruction and WB widening
- Phase 4: EB Reconstruction



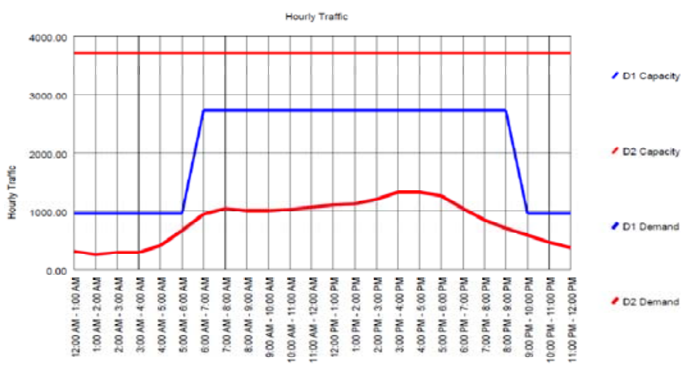
PROBLEMS FACED DURING ANALYSIS

- Most of the activities could not be modeled by CA4PRS.
- The project was a combination of widening and rehabilitation which is not supported by CA4PRS.
- Project was divided into four phases for traffic analysis.

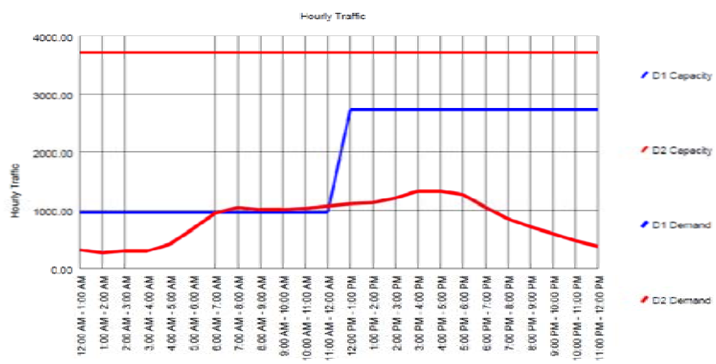
RESULTS AND ANALYSIS

	Duration	User Cost	Queue
Phase 1	50	$528,958.00	Saturdays 6 am - 12 pm
Phase 2	200	$1,589,221.00	-
Phase 3	200	$3,178,443.00	-
Phase 4	100	$1,589,221.00	-
Total		**$6,885,843.00**	

- User cost per c-day = $8,700 < Actual Incentive = $15,000 / c-day
- Traffic demand is more than capacity from 6 am to 12 pm during Saturdays
- User cost for closing one lane = $27,000/hr ~ Lane Rental Fee = $30,000/hr



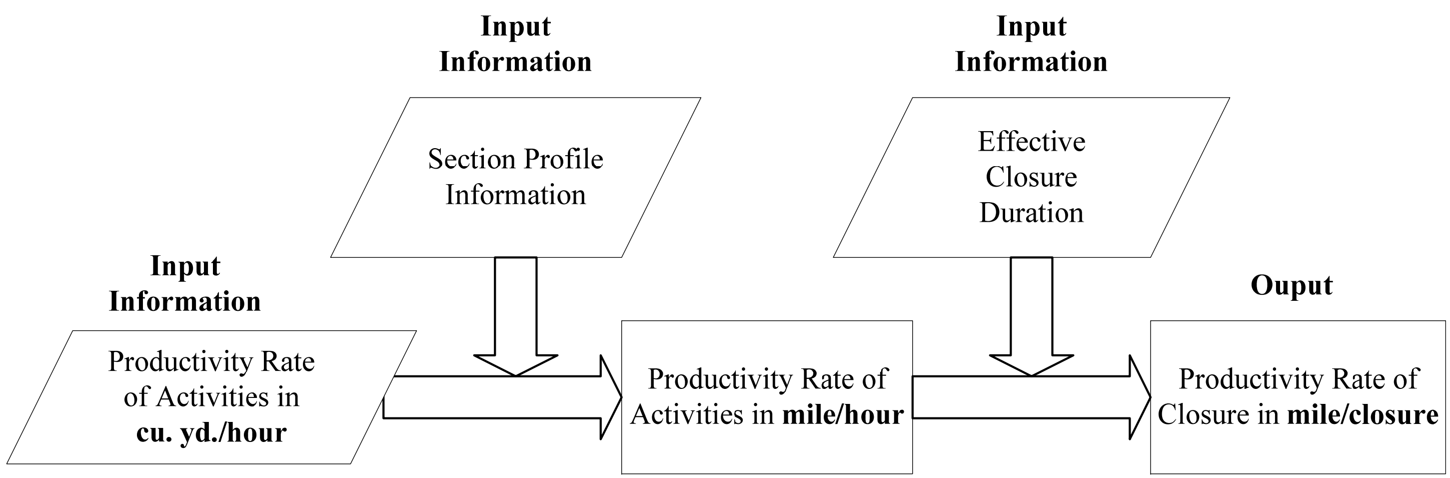
Weekdays



Saturdays

Resource Profile Information

Scheduling Process of CA4PRS



- The results are highly dependent on resource profile information.

Observed Resource Information

Resource Description	Suggested Input Data	Minimum Observed	Maximum Observed	Mean	CA4PRS Manual
Demolition Hauling Truck	Truck Capacity: 23 ton Trucks per Hour per Team: 4-6 Efficiency: 0.45 Number of Teams: 1 Team Efficiency: 0.94	3	5	4	8 to 13
Base Delivery Truck	Truck Capacity: 8 cu. yd Trucks per Hour: 6-8 Efficiency: 0.90	2	20	7	-
Batch Plant	Capacity: 200 cu. yd/hour Number of Plants: 1				
Concrete Delivery Truck	Truck Capacity: 9 cu. yd Trucks per Hour: 14-16 Efficiency: 1.0	5	22	14	9 to 16
Paver	Speed: 5.5 ft/min Number of Pavers: 1				

(Productivity Rate Required in Oklahoma) < (Productivity Rate Required in California)

Assessment of Resource Analysis

Output of CA4PRS Scheduling Analysis

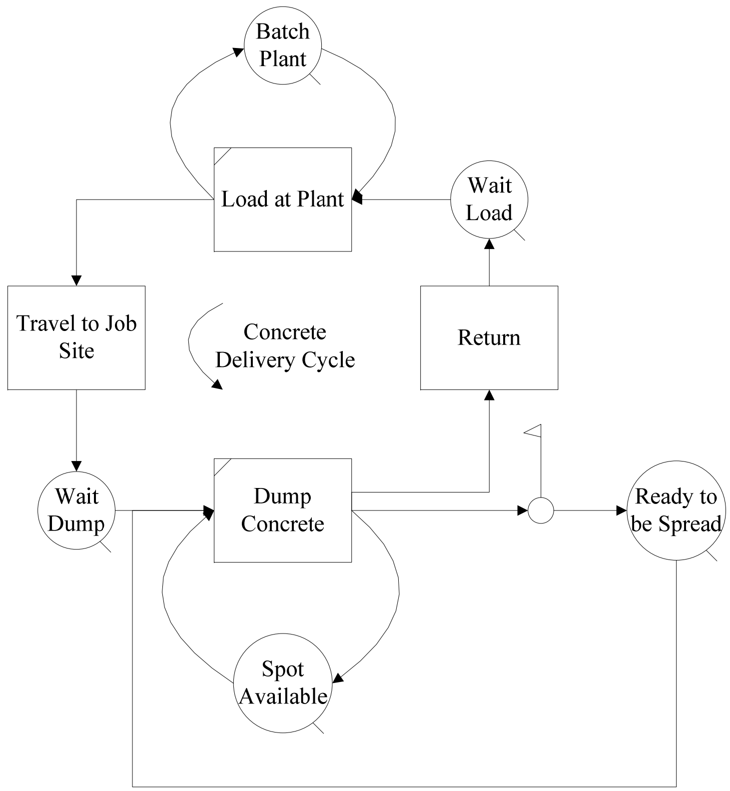
Resource	Allocated	Utilized
Demolition Hauling Truck (per Hour per Team)	10	10
Base Delivery Truck (per Hour)	5	5
Batch Plant (cu-yd/hour)	120	120
Concrete Delivery Truck (per Hour)	20	16.7
Paver Speed (ft/min)	6.6	4.6

How many trucks need to be added to or released from the operation to reach the optimum point?
Can the productivity rate be increased by adding to the number of allocated trucks?

The user may increase the number of trucks allocated to the operation with the hope of increasing the number of trucks per hour and accelerating the project while it only increases the operation costs of the project without adding to the productivity rate.

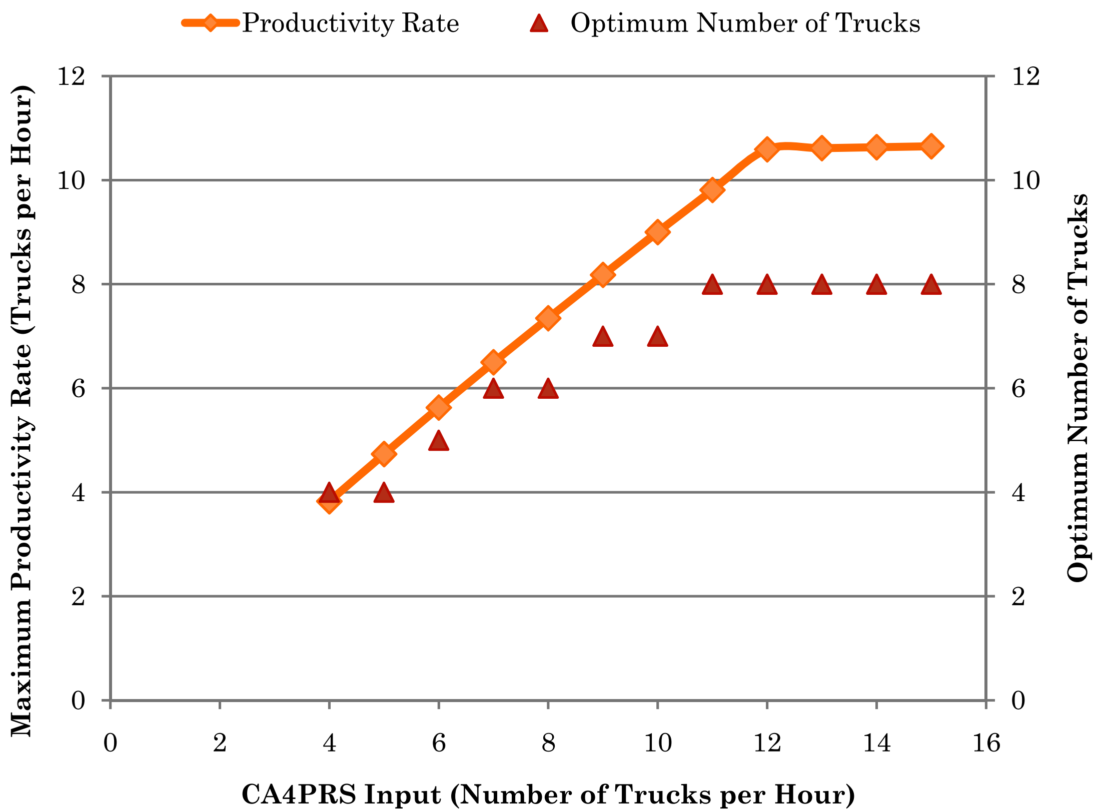
Development of a Model for Resource Profile Information

CYCLONE SIMULATION MODEL



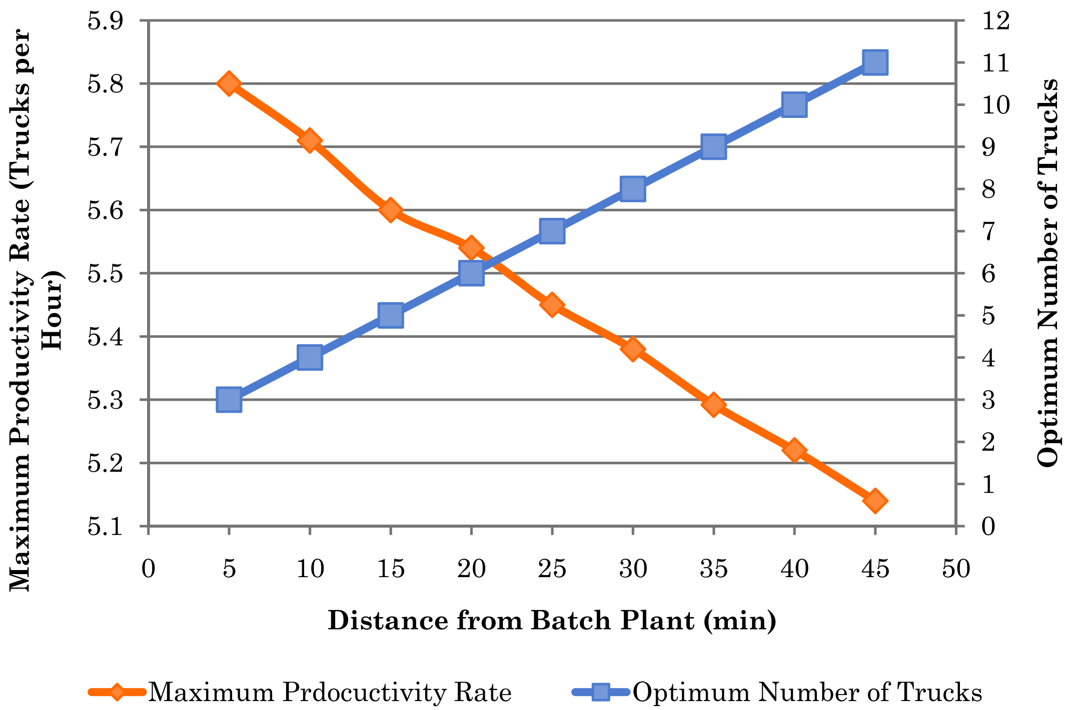
Tasks	Duration (min)	Resources	Numbers
Load at Plant	5	Batch Plant	1
Travel to Job Site	15	Trucks	10
Dump	10	Spot Available	1
Return	15		

CA4PRS Input Analysis



- Productivity does not increase necessarily by increasing CA4PRS input variable or by increasing the total number of trucks.
- There is a maximum productivity rate which is achieved by the CA4PRS input of 12 Trucks per Hour.
- Optimum number of trucks (which is required by contractors) is different from CA4PRS input.

DISTANCE FROM BATCH-PLANT

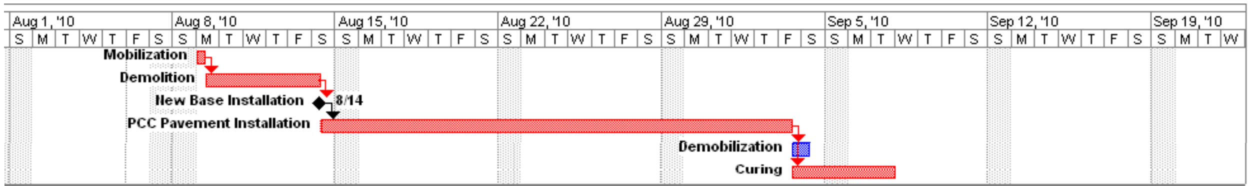


- The further the distance from the Batch Plant the less the productivity rate is.
- The further the distance from the Batch Plant the more trucks are needed, but even by allocating more trucks the maximum productivity rate decreases.

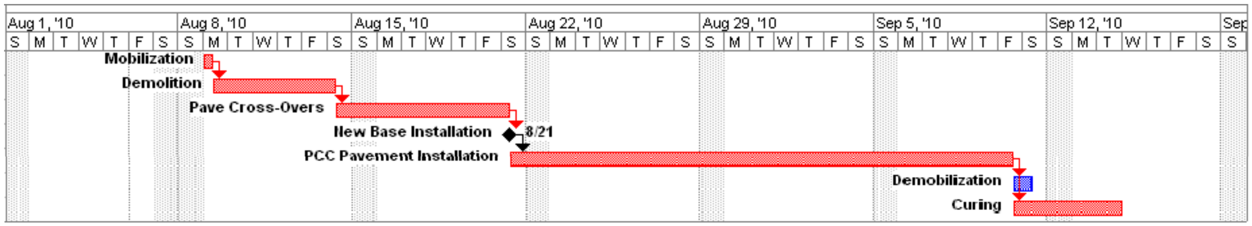
Limited Number of Activities

CPM ANALYSIS

Project Finish Dates:



September 7, 2010



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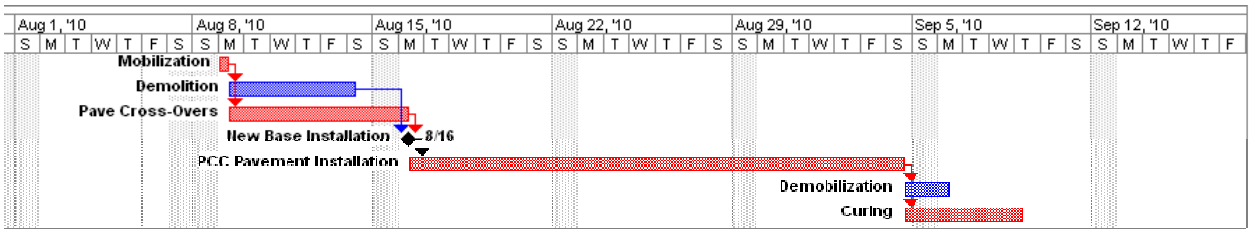

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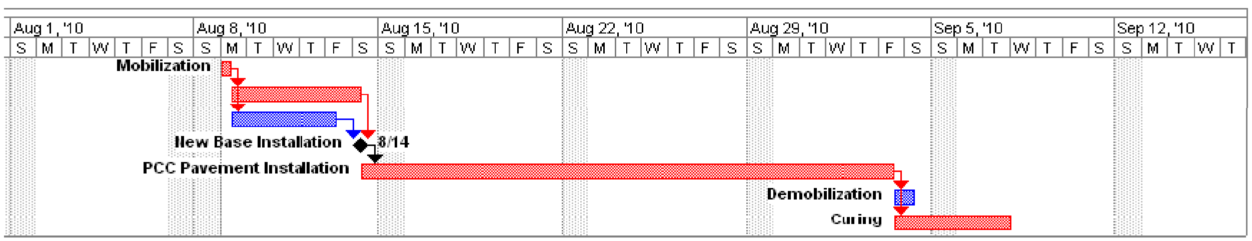


September 7, 2010

- The relationship between the main activities in CA4PRS and other rehabilitation activities not available in CA4PRS is critical.

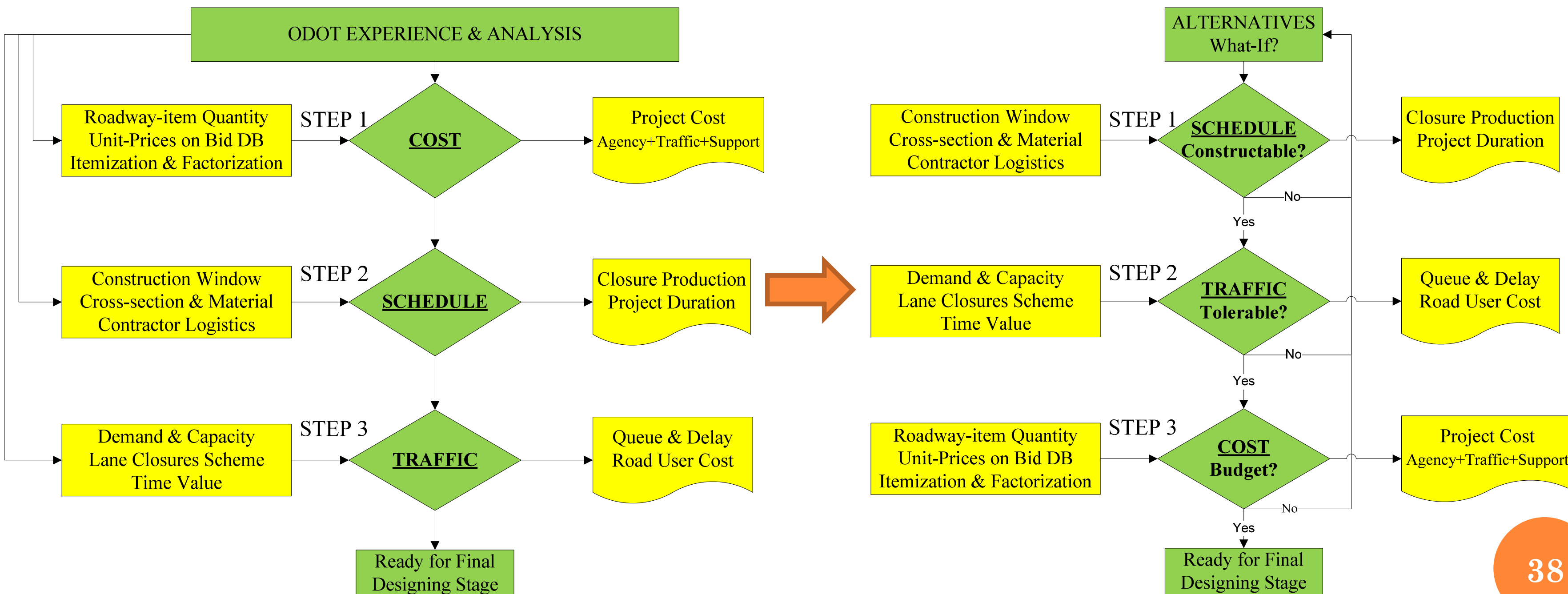
CONCLUSIONS

RESULTS

- Contractor finished the project 30 working days sooner than CA4PRS schedule.
- User cost calculated by CA4PRS ($4,000/day) is smaller than actual incentive amount ($7,500/day). (the incentive amount has been set higher to encourage the contractor to accelerate the project)
- Scheduling module cannot be used properly for large size rehabilitation projects (I-40).
- Lane rental fee calculated by CA4PRS in I-40 project is almost the same as ODOT calculations.
- The ODOT user cost calculation process is not considering the difference between traffic patterns during weekdays and weekends. CA4PRS provide the required platform for a more comprehensive work zone traffic analysis.
- The Agency Cost module was not utilized in case projects.

RECOMMENDATIONS

- ODOT; based on experience.
- Innovative; compare What-If scenarios, the optimized scenario is selected.



RECOMMENDATIONS

- The Construction Windows and Working Methods are limited in Oklahoma therefore there is a limited number of what-if scenarios.
- Currently, there is no any reliable resource profile database in ODOT.
- The daily traffic distribution data is required for Work-Zone traffic analysis.

- ODOT is encouraged to start collecting resource profile information for scheduling analysis.
- ODOT may start scheduling the projects with CA4PRS in the inception phase but they are not encouraged to use CA4PRS scheduling module extensively until the necessary data base is available.
- ODOT is encouraged to start using the Work-Zone Analysis module of CA4PRS and replace it with the existing spreadsheet program.

Thank You