Using the Measured Mile to Increase Calculated Delay Quantum

A Fiesta for Total Cost Management

Glen R. Palmer and Jeffrey L. Ottesen

Glen R. Palmer, PSP, CFCC

- Owner of GR Palmer Consulting Services, LLC
- Over 30 years experience in the engineering and construction industries
- Formerly “Corporate Head Of Planning & Scheduling” with a large engineering & construction company
- Has experience on large disputes, both domestically and internationally
- Assists clients on project front-end work

Jeffery L. Ottesen, PE, PSP, CFCC

- Owner of Alta Cascade, Inc.
- Partner of Project Controls and Forensics, LLC
- More than 21 years experience in the Engineering & Construction industries
- Former chairman of AACE's Certified Forensic Claims Consultant Board

Introduction

- This presentation is intended to convey a process for utilizing a conceptual methodology.
- It is not our intention to either assume or contend that this is an accepted approach.
- We are looking for your feedback on this process.

History of Productivity Analyses

- Fredrick W. Taylor – The Father Of Scientific Management (Early 1900s)

- He noticed 5 bricklayers working and told the superintendent that they were all laying bricks differently. The Superintendent responded, “So?”

http://en.wikipedia.org/wiki/Frederick_Winslow_Taylor

- Taylor replied with, “If one of them is doing it right, the other four are doing it wrong!”

- He was known to be popular with the bosses and not so popular with the workers

History of Productivity Analyses

- He introduced the concept of “Time and Motion” Studies

- A “Time And Motion” Study is where a complex task is:
  - Broken into small simple steps
  - The sequence of movements of each employee in the performance of those steps is observed to detect and eliminate wasteful motion
  - The time taken for each correct movement is measured

Traditional Use Of Productivity Analyses

- Productivity analyses are traditionally used for reasons such as:
  - To create a database of historical information that can be used for bidding work (Cost & Schedule). This information is important due to the impacts relating to:
    - Geographic Locations
    - Skilled Labor
    - Weather

Traditional Use Of Productivity Analyses

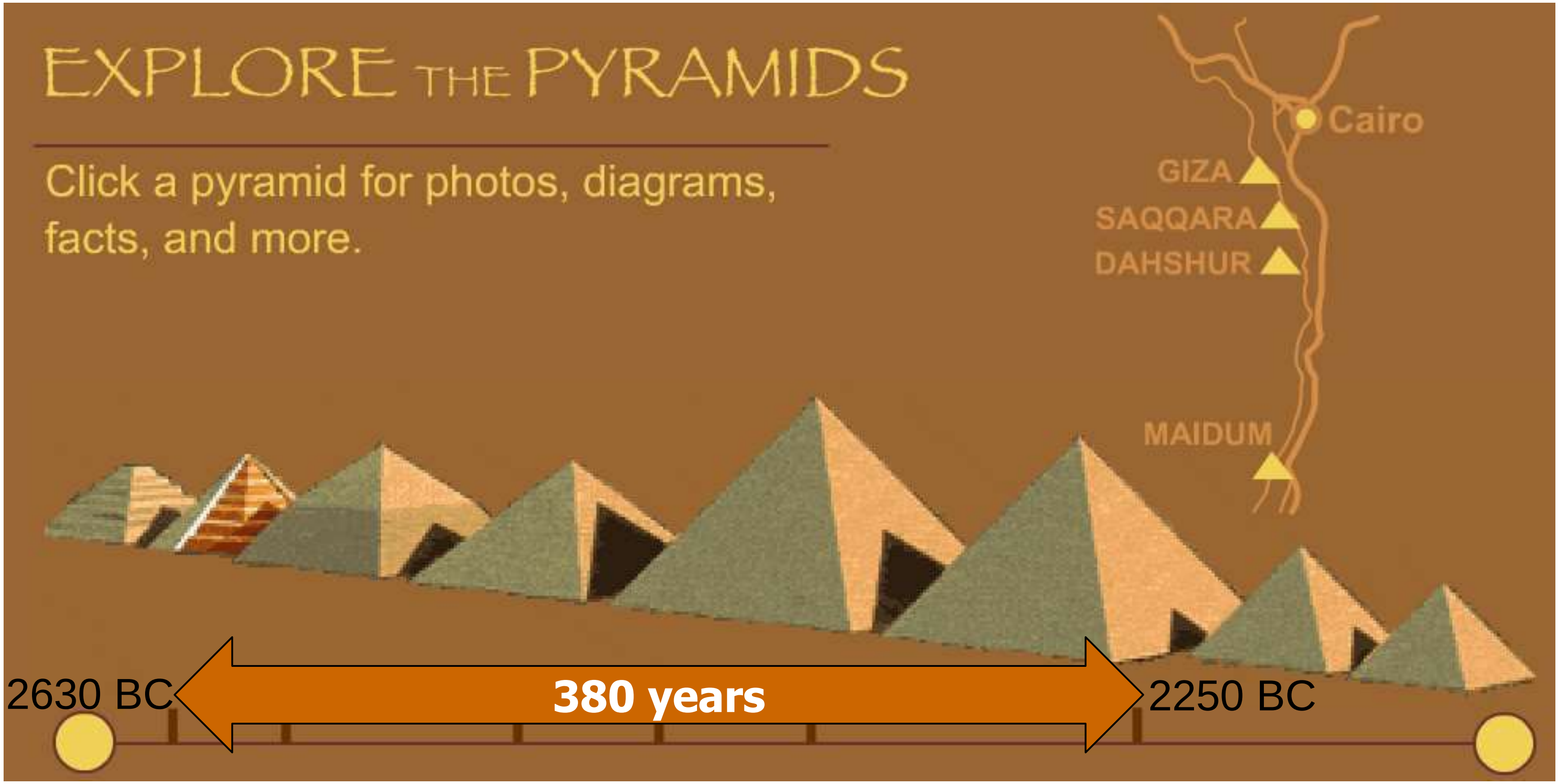
- Productivity analyses are traditionally used for reasons such as:
  - Analyzing project work history for claims
  - Predicting project impacts such as overtime
  - Determining the resources required for a project

Traditional Use Of Productivity Analyses

- I first used a productivity analysis in the late 70’s on a nuclear power plant to predict the schedule’s critical path activity durations for an award fee program by:
    - Analyzing historical data of similar work
    - Predicting the durations of similar future work
    - Assigning award fee dollars to the successful completion of that work

History of Delay Analysis

Were the Pyramids Constructed On Time and Within Budget?



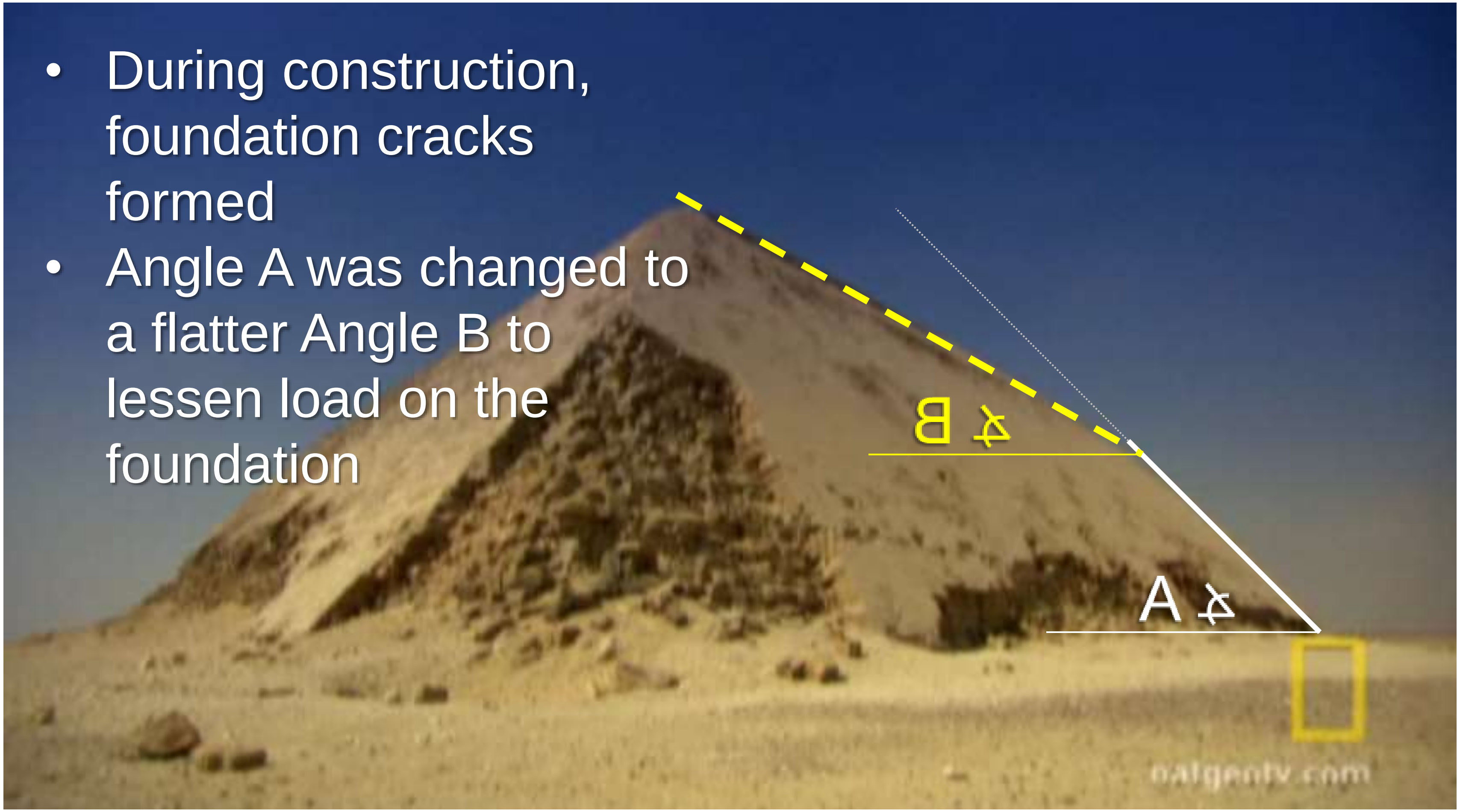
EXPLORE THE PYRAMIDS

Click a pyramid for photos, diagrams, facts, and more.

Source: http://www.nationalgeographic.com/pyramids/pyramids.html

Snesferu’s Bent Pyramid

Early Example of a Delayed Project



- During construction, foundation cracks formed
- Angle A was changed to a flatter Angle B to lessen load on the foundation

http://video.nationalgeographic.com/video/player/national-geographic-channel/specials-1/treasures-of-egypt/ngc-sneferus-bent-pyramid.html

History of Delay Analysis

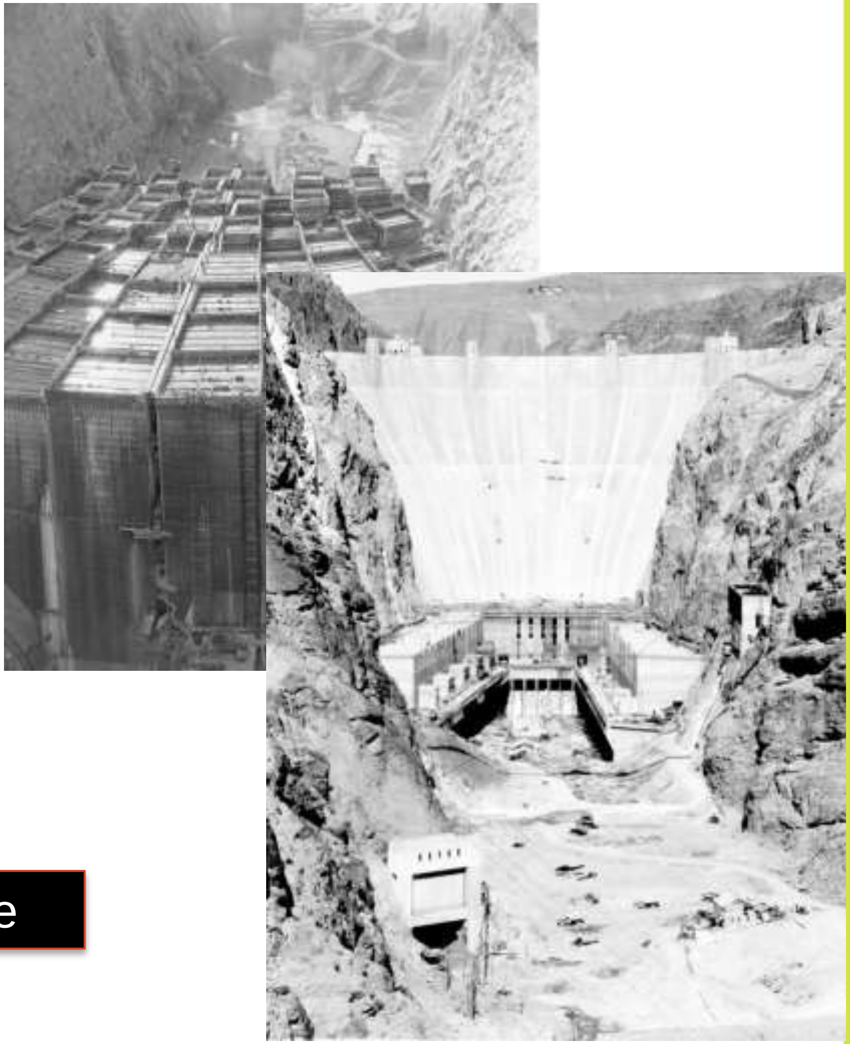
- Comparison of plan v. actual has been around for centuries
  - Biblical Old Testament References (< 1000 BC)
    - Construction of ancient structures (e.g., Solomon's Temple) and cities
  - Sun Tsu *"The Art of War"* (6th century BC)
    - Preparations to complete before winter
  - Roman Empire (27 BC to 1400's AD)
    - Cities, walls, aqueducts and roadway system
  - Early American Settlers – Jamestown (early 1600's)
    - Building shelters and planting crops

History of Delay Analysis

Example: Boulder Dam Construction 1930 - 1935

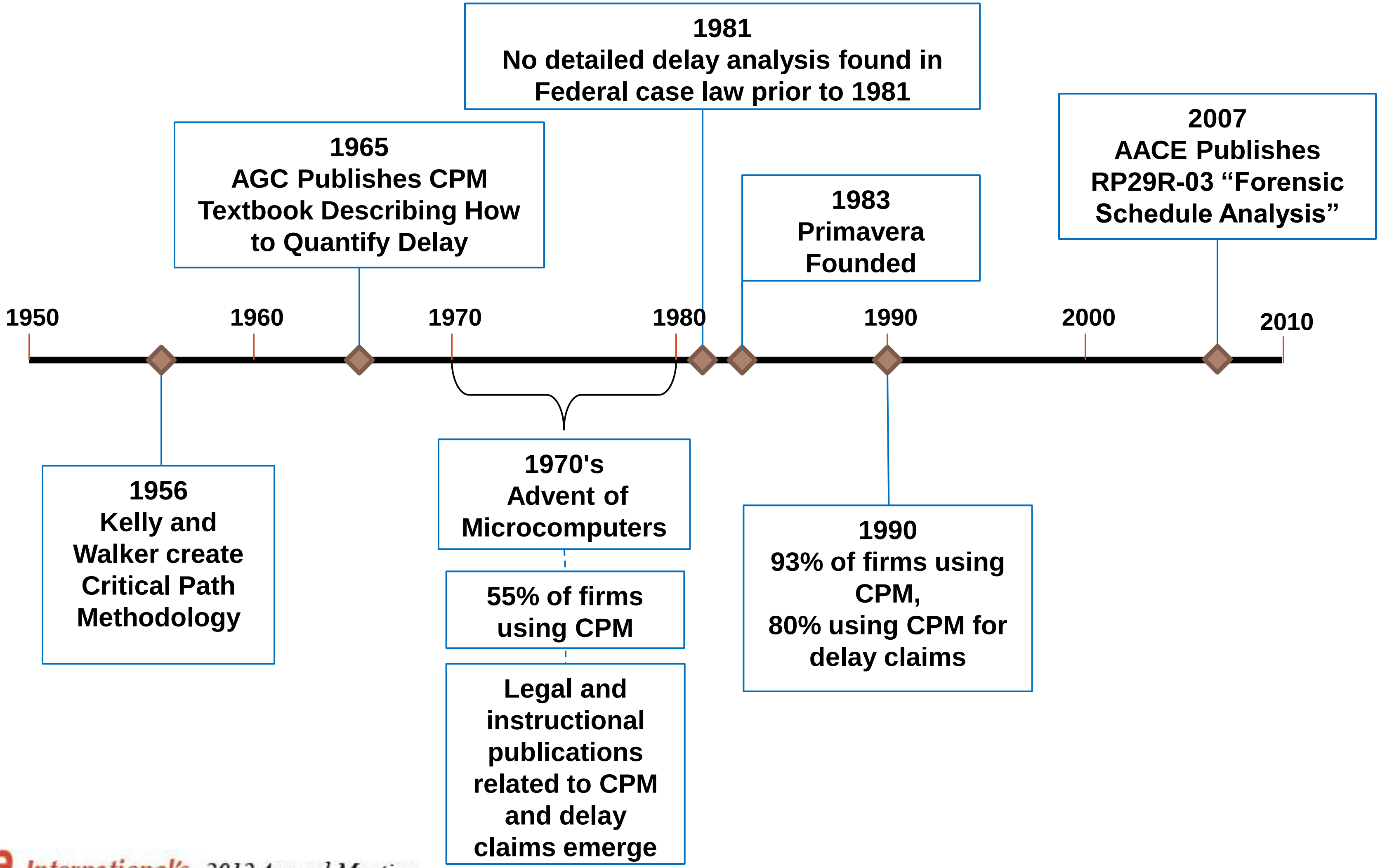
- Six Company won the contract with a bid of $48,890,955
- Incentive bonuses were offered
- Fines applied for each day construction overran the assigned schedule
- Essentially working 24 x 7, 107 workers died during construction
- The project finished 2 years ahead of schedule

CPM did not exist at this time



Source of Photos: http://www.arizona-leisure.com

Advent of CPM in 1956



1956
Kelly and Walker create Critical Path Methodology

1965
AGC Publishes CPM Textbook Describing How to Quantify Delay

1970's
Advent of Microcomputers

55% of firms using CPM

Legal and instructional publications related to CPM and delay claims emerge

1981
No detailed delay analysis found in Federal case law prior to 1981

1983
Primavera Founded

1990
93% of firms using CPM,
80% using CPM for delay claims

2007
AACE Publishes RP29R-03 “Forensic Schedule Analysis”

Traditional Use of Delay Analysis

- Delay analyses are traditionally used for reasons such as:
    - Contractors use delay analyses to determine why it's schedule has slipped and who caused the slip. These analyses often lead to claims against owners and subcontractors.
    - Owners use delay analyses to determine why the contractor's schedule has slipped and who caused the slip. These analyses are often used in claims against the contractor.

Why Combine Delay and Productivity?

- A Productivity Analysis measures the inefficient use of resources
- A Delay Analysis, in part, measures the inefficient use of time
- Both analyses measure inefficiencies - productivity

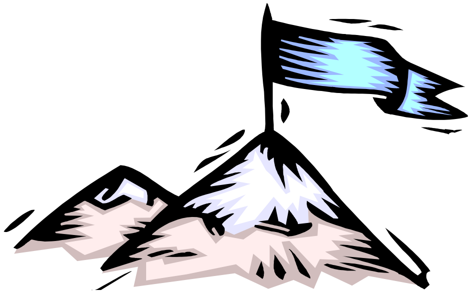
Why Combine Delay and Productivity?

- Delay Damages – Generally delay damages are where the real money resides (e.g., a large project can cost $100K or more per day in time driven costs)
- Productivity Damages – Domestically can be expensive, but internationally may only cost $10 - $15 per hour
  - If the work is subcontracted, a general contractor is only disrupted if a subcontractor files a claim
- Therefore, making the delay quantum increase is a good thing

Why Combine Delay and Productivity?

- I came up with this idea while working on an international dispute where my client was losing tens of millions of dollars and the average wage rate was $6.50 per hour

- Mathematically, it was going to take an incredible amount of inefficient hours to recover just a few million dollars



Why Combine Delay and Productivity?

- It was obvious to me that I needed to come with an approach to increase the delay days attributable to the owner

- Jeff and I discussed this and worked out our following methodology to achieve just that

Case Law Findings

- We performed a search on Westlaw for cases involving delay and productivity analyses for construction projects
- After reviewing scores of cases including appeals, the following list of prerequisites was prepared in winning a productivity loss claim

Prerequisites to Winning a Productivity Claim

- Must establish cause and effect using contemporaneous project documentation
  - Bid estimate must be reasonable
  - Testimony alone is insufficient evidence
  - Use of impact factors (e.g., MCAA) or estimating techniques (e.g., RS Means) can be subjective and are less accepted than objective analyses
- Measured Mile approach most widely accepted
- Delay quantum analyses are rarely directly correlated to productivity loss and are commonly considered separate analyses

Correlation – Delay & Productivity

Productivity can be affected by many factors that disrupt the efficient performance of work, including multiple changes, interference, delays, alterations in sequencing, suspension and acceleration. These factors may cause a contractor to reassign workers, stack trades and perform work out of sequence, ultimately causing lost productivity and an increase of labor costs. Id. at 313-15.

Source: Michael R. Finke, Claims for Construction Productivity Losses, 26 PUB. CONT. L.J. (1997) and cited in Appeal of Bay Construction Co., VABCA, 2002

Logic Statements

The Trouble with Absolute If ⇨ Then Logic Statements

If delay occurs, then productivity loss results

Delay ⇨ Productivity Loss

The converse argument must also true:
If no productivity loss occurs, then no delay occurred

No Productivity Loss ⇨ No Delay

These statements too may not be true if unsupported by the project records

It is NOT necessarily true, however, to say:
If productivity loss occurs, then delay also occurs

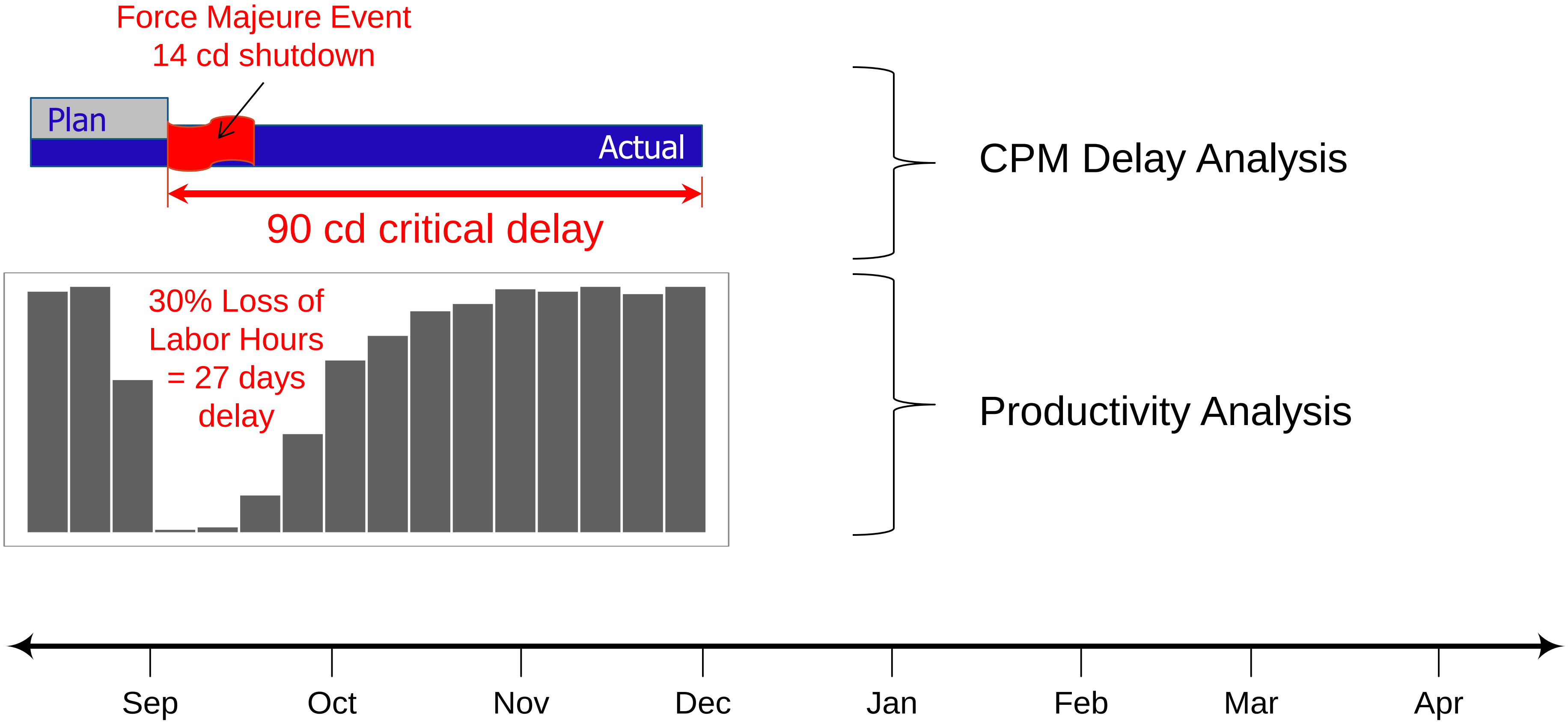
Productivity Loss ⇏ Delay

Correlated – Delay & Productivity

- Drilling contractor restricted to a 3-hour work day instead of planned 7-hour work day due to extreme summer heat
  - (7 – 3) ÷ 7 = 57% loss of productive time
  - Claimed (and awarded) a total of 14 days delay for the hot days that restricted productive work

Source: Appeal of Bechtel Environmental, Inc., ENGBCA, 1996

Not Correlated – Delay & Productivity



Our Proposed Methodology

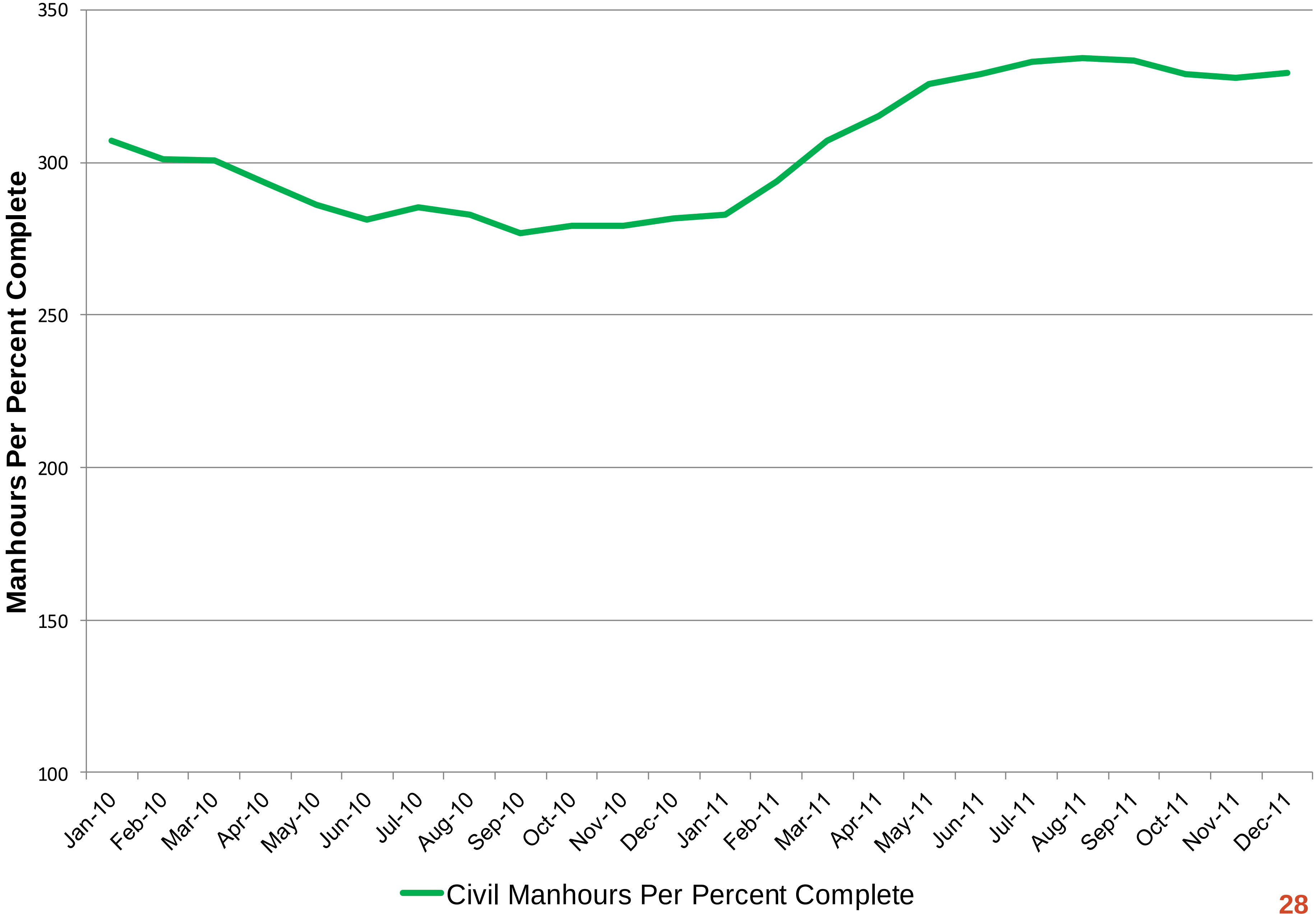
- Let’s assume that we have prepared both a productivity analysis and a delay analysis for our project

- In our analysis we have performed a “Measured Mile” analysis using a generally accepted methodology

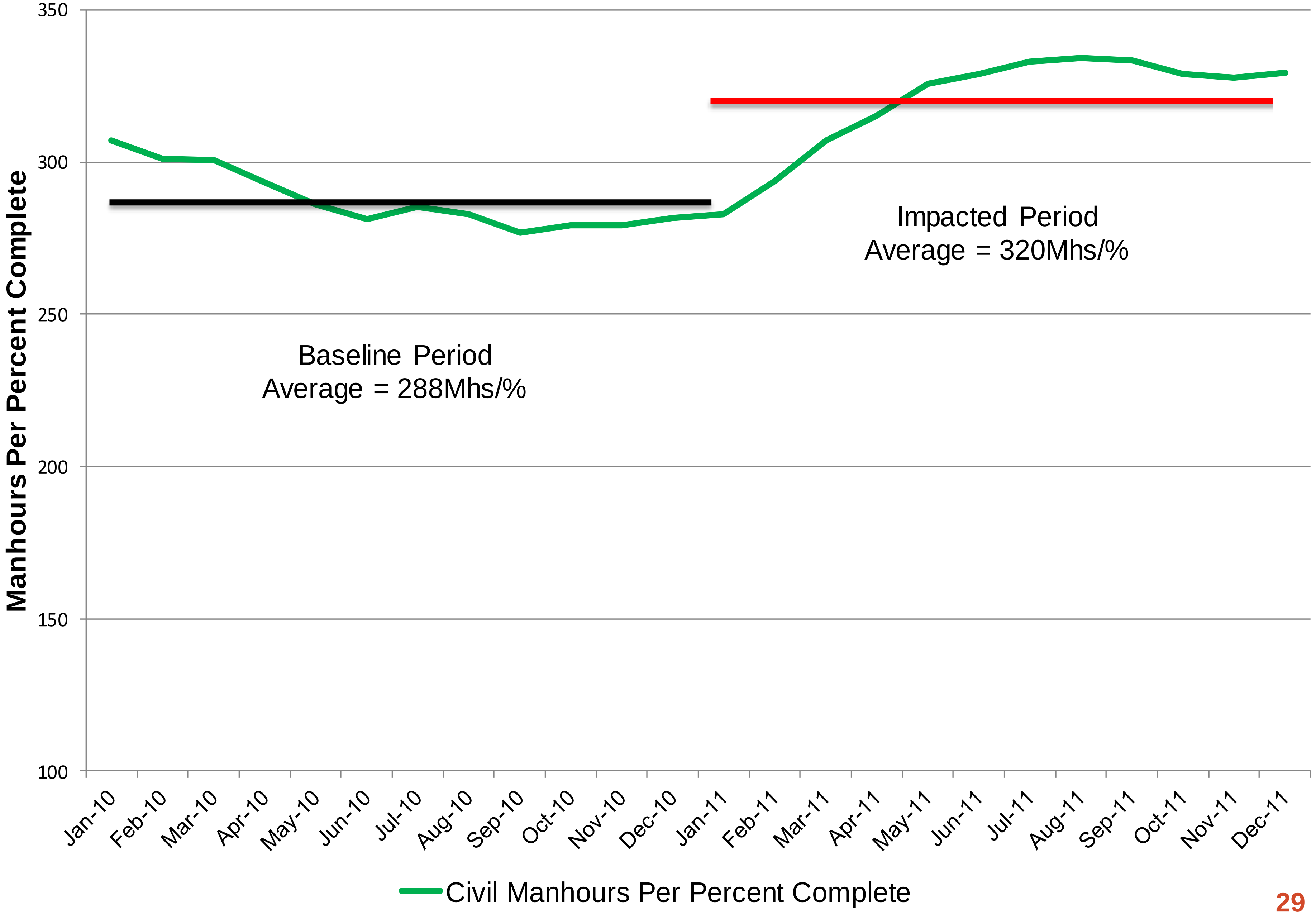
- We have also performed a delay analysis using the “Window Analysis” methodology (an accepted methodology)

Our Measured Mile Analysis

Civil Manhours Per Percent Complete



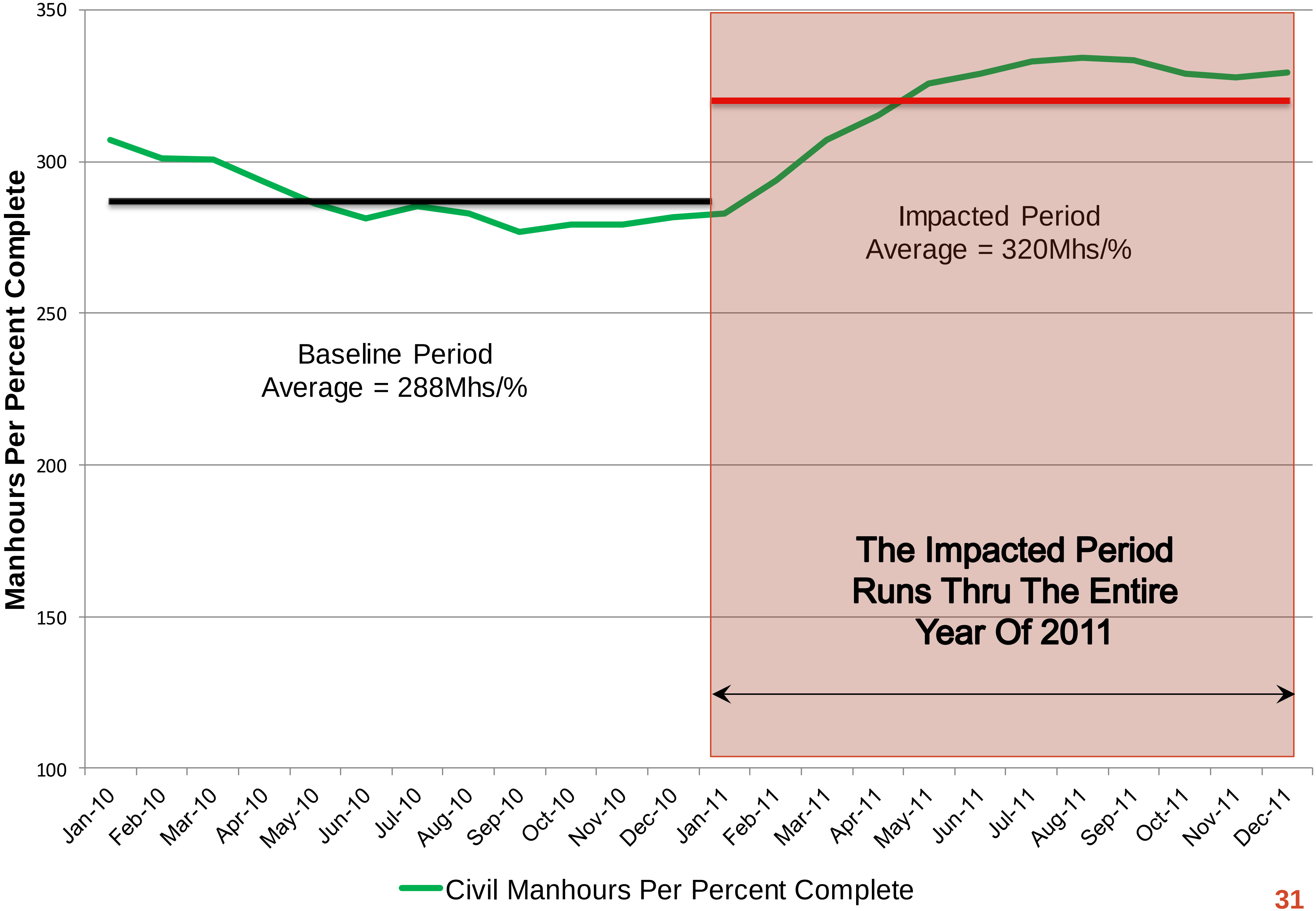
Civil Manhours Per Percent Complete



Our Proposed Methodology

- Our “Measured Mile” analysis shows:
  - During the un-impacted period of our analysis, civil was able to accomplish on an average, 1 percent of the total civil scope for 288 manhours
  - During the impacted period of our analysis, civil was only able to accomplish on an average, 1 percent of the total civil scope for 320 manhours
  - In essence, for every 320 manhours expended during the impacted period (all of 2011), 32 (320 – 288 = 32) or 10 percent were inefficient

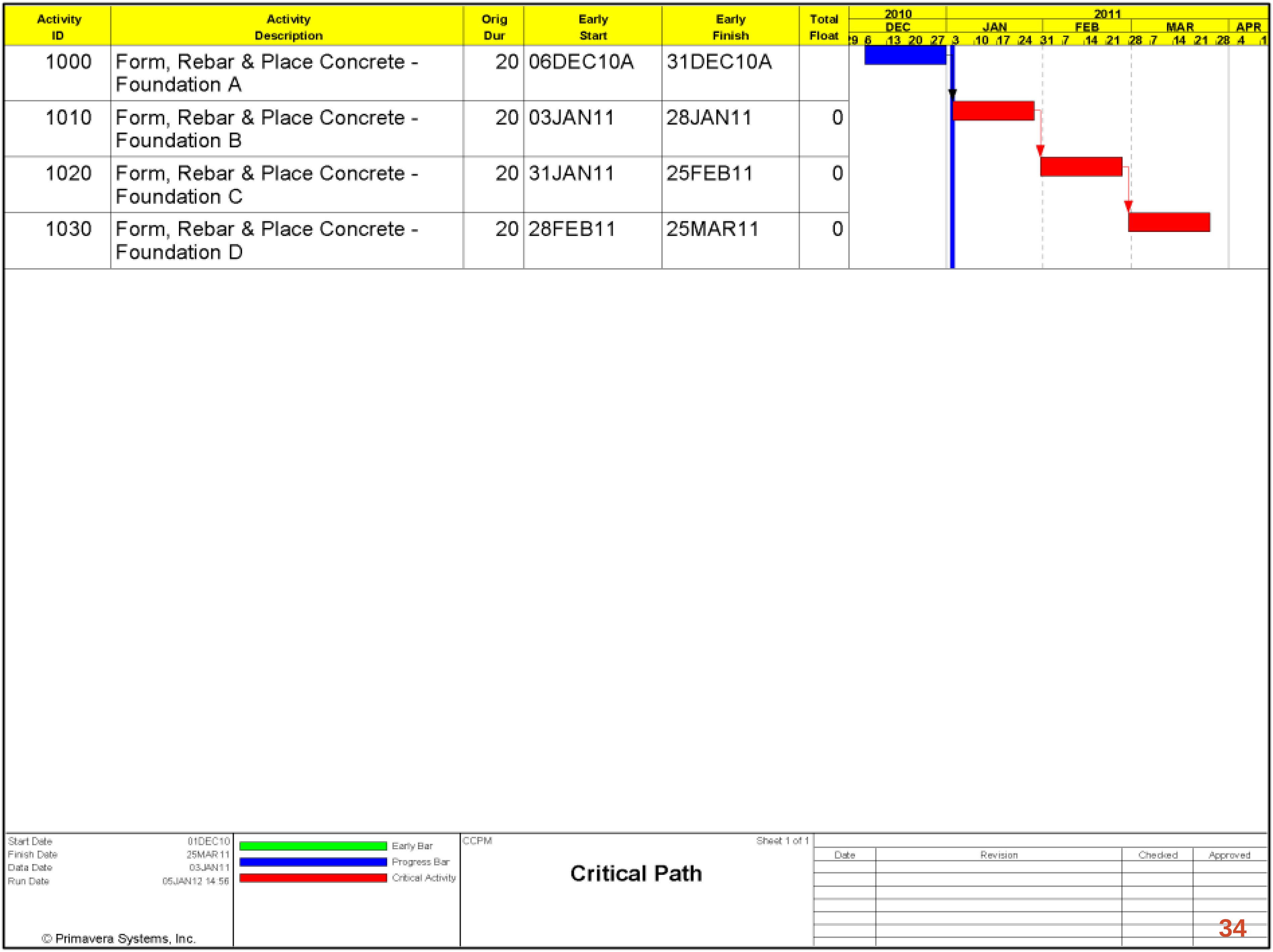
Civil Manhours Per Percent Complete



Our Delay Analysis

Our Proposed Methodology

- Types of delay
  - Start Delay
  - Production Delay
- We are only concerned here with the production delay, which is a delay due to the work taking longer than planned – productivity related



Activity ID	Activity Description	Orig Dur	Early Start	Early Finish	Total Float
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11	28JAN11	0
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	0
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	0

Start Date	01DEC10
Finish Date	25MAR11
Data Date	03JAN11
Run Date	05JAN12 14:56

🟩 Early Bar

🟦 Progress Bar

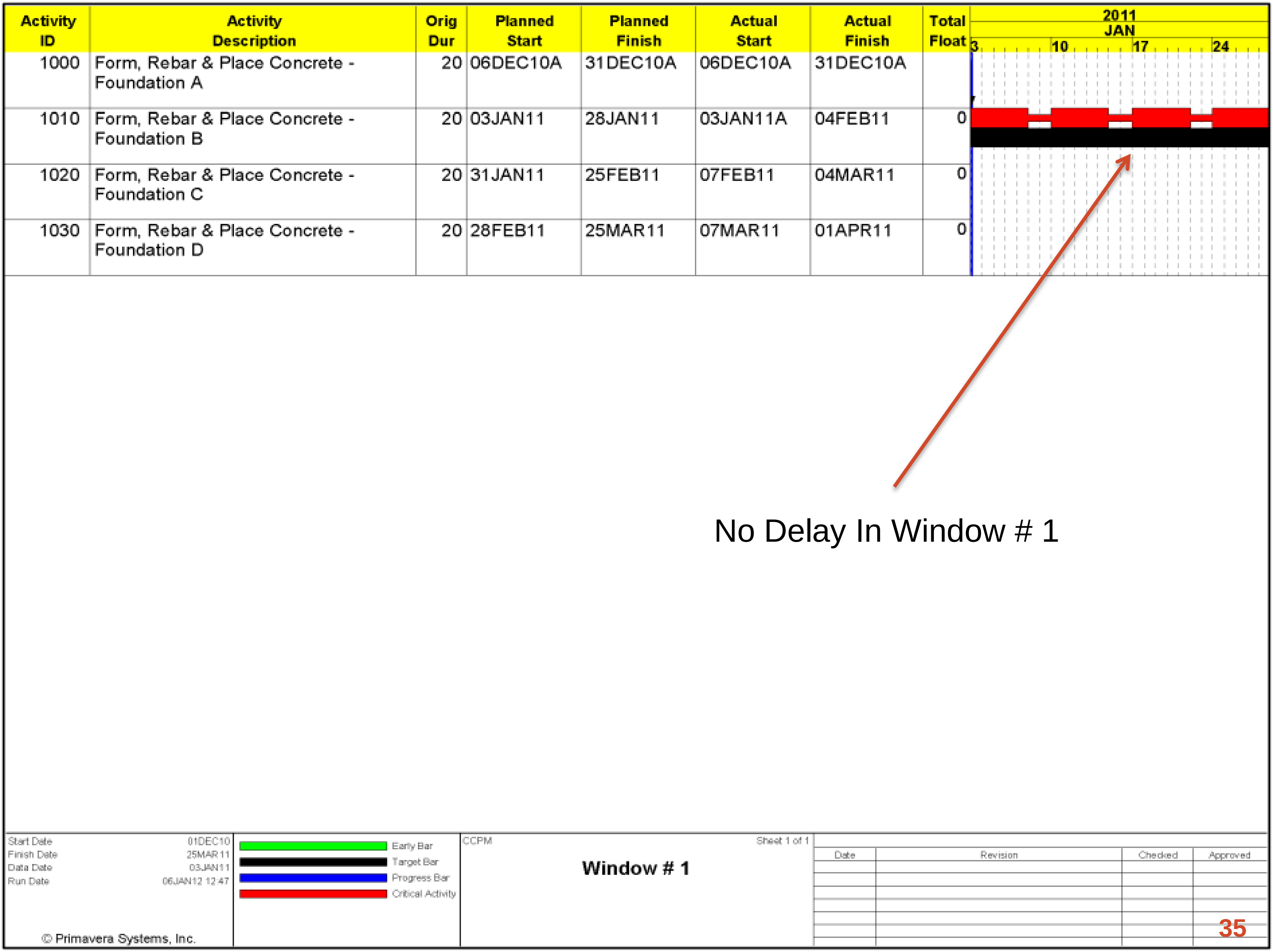
🟥 Critical Activity

CCPM

Sheet 1 of 1

Critical Path

Date	Revision	Checked	Approved



Activity ID	Activity Description	Orig Dur	Planned Start	Planned Finish	Actual Start	Actual Finish	Total Float
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	06DEC10A	31DEC10A	
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11	28JAN11	03JAN11A	04FEB11	0
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	07FEB11	04MAR11	0
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	07MAR11	01APR11	0

No Delay In Window # 1

Start Date	01DEC10
Finish Date	25MAR11
Data Date	03JAN11
Run Date	06JAN12 12:47

© Primavera Systems, Inc.

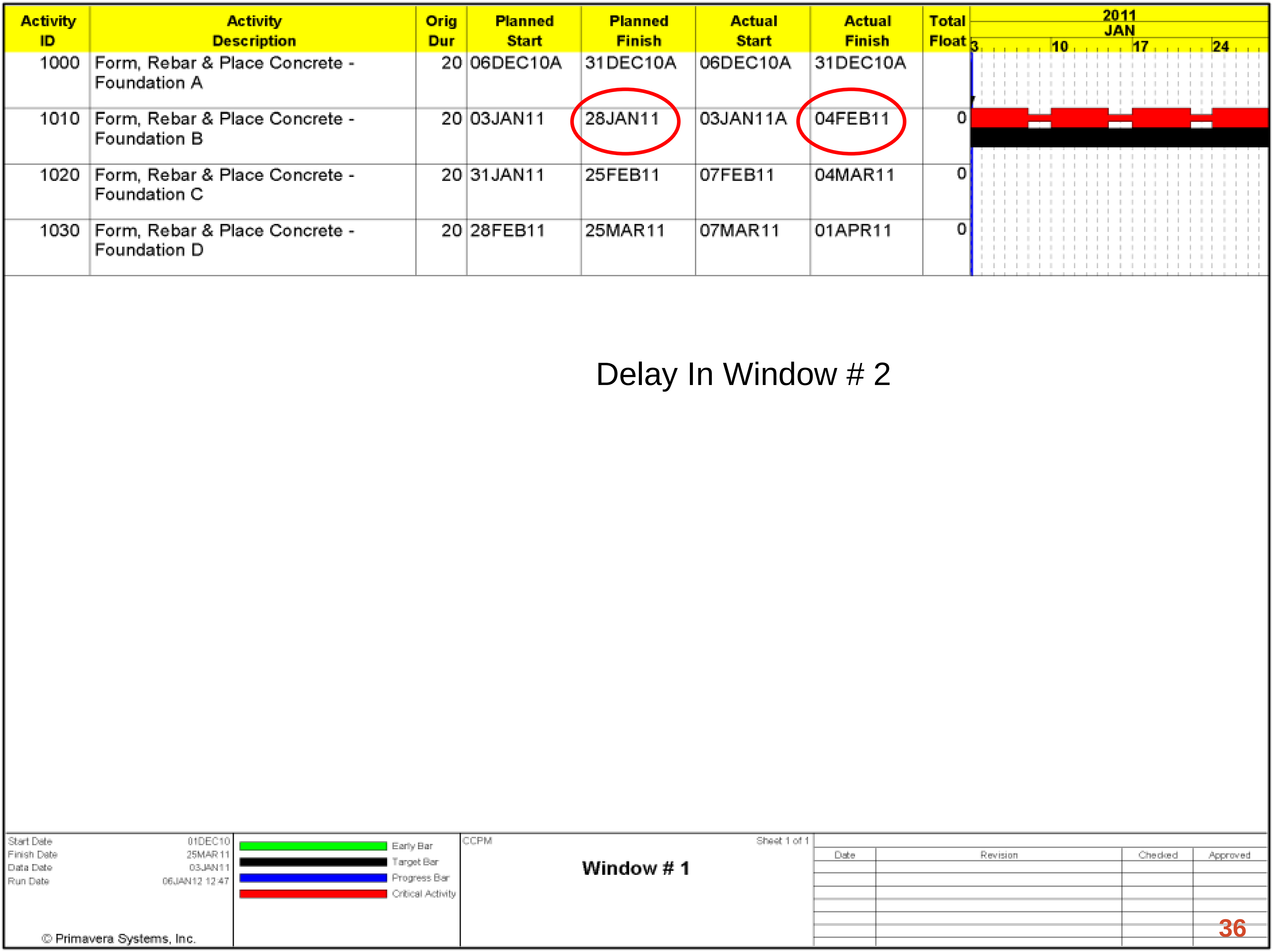
🟩	Early Bar
⬛	Target Bar
🟦	Progress Bar
🟥	Critical Activity

CCPM

Sheet 1 of 1

Window # 1

Date	Revision	Checked	Approved



Activity ID	Activity Description	Orig Dur	Planned Start	Planned Finish	Actual Start	Actual Finish	Total Float
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	06DEC10A	31DEC10A	
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11	28JAN11	03JAN11A	04FEB11	0
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	07FEB11	04MAR11	0
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	07MAR11	01APR11	0

Delay In Window # 2

Start Date	01DEC10
Finish Date	25MAR11
Data Date	03JAN11
Run Date	06JAN12 12:47

© Primavera Systems, Inc.

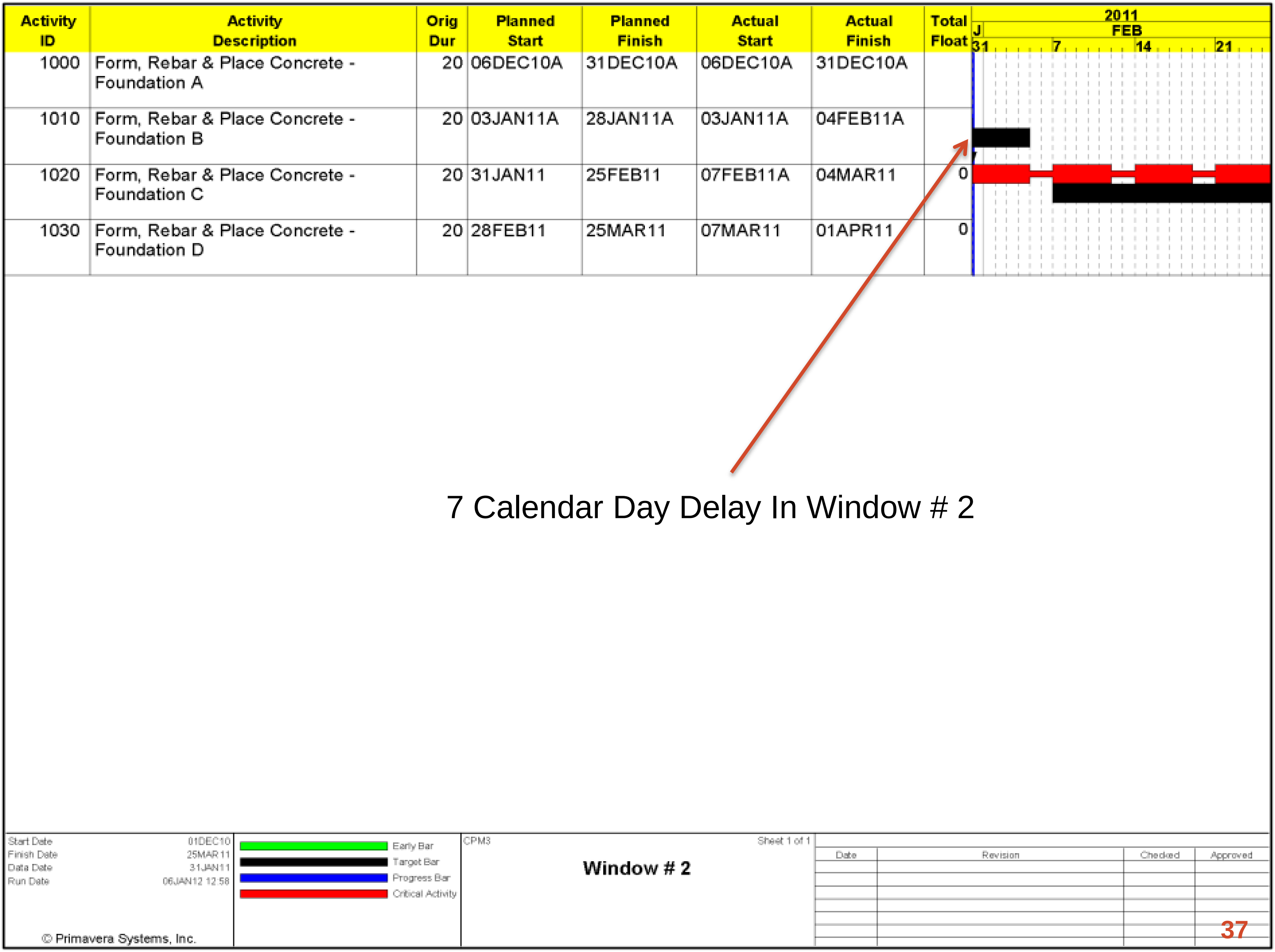
🟩 Early Bar
▬ Target Bar
▬ Progress Bar
🟥 Critical Activity

CCPM

Sheet 1 of 1

Window # 1

Date	Revision	Checked	Approved



Activity ID	Activity Description	Orig Dur	Planned Start	Planned Finish	Actual Start	Actual Finish	Total Float
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	06DEC10A	31DEC10A	
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11A	28JAN11A	03JAN11A	04FEB11A	
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	07FEB11A	04MAR11	0
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	07MAR11	01APR11	0

7 Calendar Day Delay In Window # 2

Start Date	01DEC10
Finish Date	25MAR11
Data Date	31JAN11
Run Date	06JAN12 12 58

© Primavera Systems, Inc.

🟩 Early Bar
⬛ Target Bar
🟦 Progress Bar
🟥 Critical Activity

CPM3

Sheet 1 of 1

Window # 2

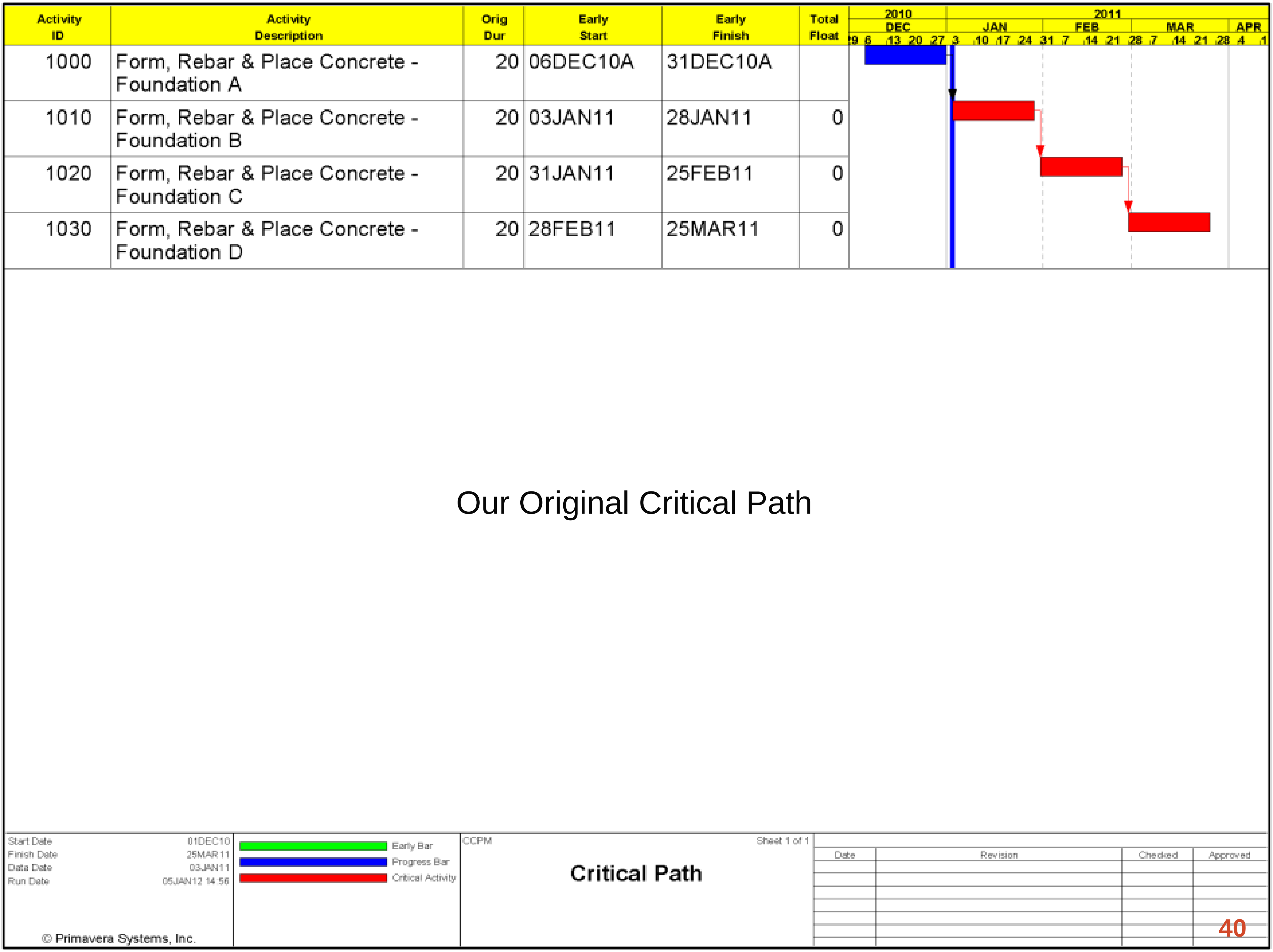
Date	Revision	Checked	Approved

Our Proposed Methodology

- 7 days of production delay
  - Our causation analysis shows that this foundation incurred a 7 day production delay due to soil conditions – owner caused
- This is a normal delay for which our analysis shows the other side to be responsible – this is not the type of production delay for which we are trying to make a case

Our Proposed Methodology

- Productivity Analysis:
  - In our Productivity Analysis we concluded that that we are entitled to 10 percent of all of the civil manhours expended during the calendar year of 2011
  - Why then would we not be entitled to the delay to the schedule that resulted from this entitled inefficiency?



Activity ID	Activity Description	Orig Dur	Early Start	Early Finish	Total Float
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11	28JAN11	0
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	0
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	0

Our Original Critical Path

Start Date	01DEC10
Finish Date	25MAR11
Data Date	03JAN11
Run Date	05JAN12 14:56

🟩 Early Bar

🟦 Progress Bar

🟥 Critical Activity

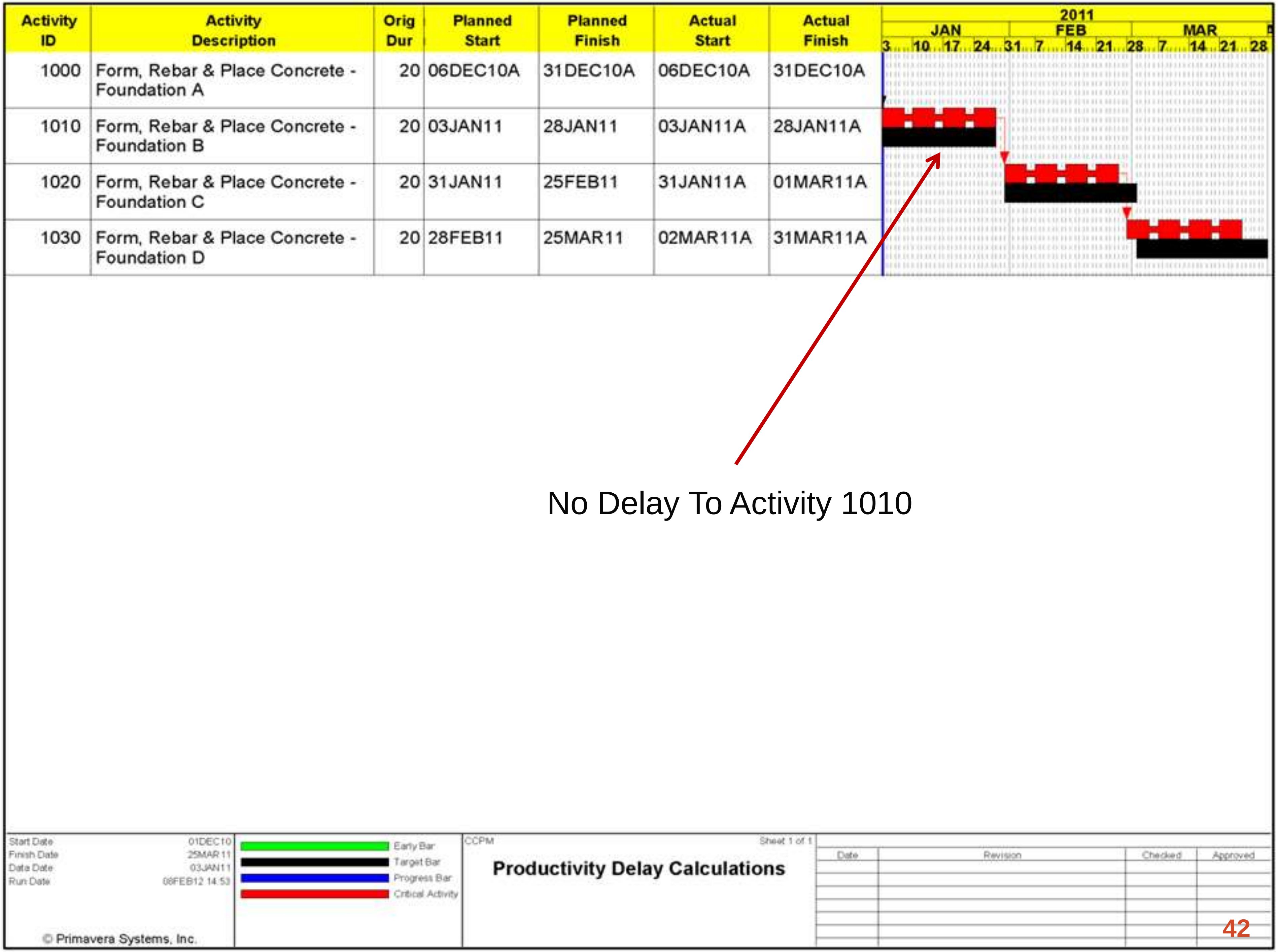
CCPM

Sheet 1 of 1

Critical Path

Date	Revision	Checked	Approved

Our Productivity Delay Calculations



Activity ID	Activity Description	Orig Dur	Planned Start	Planned Finish	Actual Start	Actual Finish
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	06DEC10A	31DEC10A
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11	28JAN11	03JAN11A	28JAN11A
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	31JAN11A	01MAR11A
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	02MAR11A	31MAR11A

No Delay To Activity 1010

Start Date	01DEC10
Finish Date	25MAR11
Data Date	03JAN11
Run Date	08FEB12 14:53

© Primavera Systems, Inc.

- 🟩 Early Bar
- ⬛ Target Bar
- 🟦 Progress Bar
- 🟥 Critical Activity

CCPM

Sheet 1 of 1

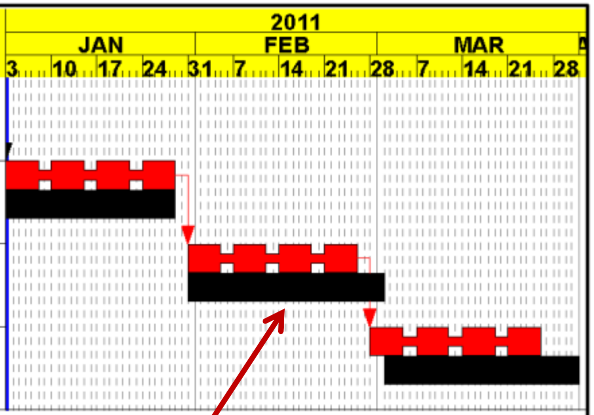
Productivity Delay Calculations

Date	Revision	Checked	Approved

Our Proposed Methodology

- Our Productivity Delay Calculations:
  - We show no delay to Activity 1010 because we have concluded earlier that the delay associated with activity was due to soil conditions – a direct impact

Activity ID	Activity Description	Orig Dur	Planned Start	Planned Finish	Actual Start	Actual Finish
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	06DEC10A	31DEC10A
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11	28JAN11	03JAN11A	28JAN11A
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	31JAN11A	01MAR11A
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	02MAR11A	31MAR11A



4 Calendar Day Delay To Activity 1020

Start Date	01DEC10
Finish Date	25MAR11
Data Date	03JAN11
Run Date	08FEB12 14:53

🟩 Early Bar
⬛ Target Bar
🟦 Progress Bar
🟥 Critical Activity

CCPM

Sheet 1 of 1

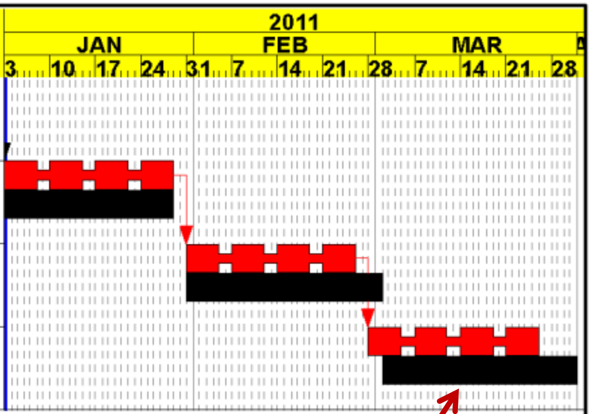
Productivity Delay Calculations

Date	Revision	Checked	Approved

Our Proposed Methodology

- Our Productivity Delay Calculations:
  - We show a 4 calendar day delay to Activity 1020 because we have concluded that we are entitled to a 10 percent inefficiency due to productivity
  - Original Duration of 20 work days times 10 percent equals 22 day revised duration
  - When this 22 day duration is plugged into our schedule it is a 4 calendar day increase due to the weekend

Activity ID	Activity Description	Orig Dur	Planned Start	Planned Finish	Actual Start	Actual Finish
1000	Form, Rebar & Place Concrete - Foundation A	20	06DEC10A	31DEC10A	06DEC10A	31DEC10A
1010	Form, Rebar & Place Concrete - Foundation B	20	03JAN11	28JAN11	03JAN11A	28JAN11A
1020	Form, Rebar & Place Concrete - Foundation C	20	31JAN11	25FEB11	31JAN11A	01MAR11A
1030	Form, Rebar & Place Concrete - Foundation D	20	28FEB11	25MAR11	02MAR11A	31MAR11A



6 Calendar Day Delay To Activity 1030

Start Date	01DEC10
Finish Date	25MAR11
Data Date	03JAN11
Run Date	08FEB12 14:53

🟩 Early Bar
⬛ Target Bar
🟦 Progress Bar
🟥 Critical Activity

CCPM

Sheet 1 of 1

Productivity Delay Calculations

Date	Revision	Checked	Approved

Our Proposed Methodology

- Our Productivity Delay Calculations:
  - We show a 6 calendar day delay to Activity 1030 because we have concluded that we are entitled to a 10 percent inefficiency due to productivity
  - Original Duration of 20 work days times 10 percent equals 22 day revised duration
  - When this 22 day duration is plugged into our schedule it is a 6 calendar day increase in total (2 & 4 = 6)

Our Proposed Methodology

- Conclusions:
  - In a very simple example we have increased the calculated delay quantum by 6 calendar days from a 10 percent inefficiency
  - On a good sized project this could be worth hundreds of thousands of dollars
  - This same approach needs to be applied to the structural, mechanical, piping, electrical, instrumentation, painting & etc.

Our Proposed Methodology

- Caution:
  - We recommend that you separate the final delay calculations into two subtotals:
    - The normal delays calculations based on your causation analysis
    - The delay calculations based on the “measured mile” analysis
  - This approach may save you some time if this methodology is not approved by the trier of fact

Our Proposed Methodology

- Caution:
  - You need to ensure that each activity you assign an additional delay to, actually had a production delay, or in other words was actually being worked on during that time period. An activity can appear to have a production delay when in fact it is just an activity that had not completed but was not being worked for a portion of the delay period
  - The productivity delays must occur in the same time period as the measured mile impacted period

Questions / Comments

Thank You

This Concludes Our Presentation

Contact Information

Name: Glen R. Palmer, PSP, CFCC
Title: Owner
Company: GR Palmer Consulting Services, LLC
Email Address: gpalmer@gpalmer.com
Phone Number: +1 (603) 591-6754

Name: Jeffery L. Ottesen, PE, PSP, CFCC
Title: Owner
Company: PCF/Alta Cascade, Inc.
Email Address: jottesen@altacascade.com
Phone Number: +1 (253) 864-6800